THURSDAY, APRIL 8, 1880

MUSICAL PITCH

ALTHOUGH the outside world knows little about it, the question of musical pitch causes great anxiety to the public singer, to the conductor of operas and choirs, and to musical instrument-makers generally. Musical instruments are divided into two classes: those with fixed and those with variable tones. The first comprises organs and pianos and most brass and wood wind-instruments. The trombone, the bowed instruments, and the human voice are variable. Even the latter, however, can vary only within narrow limits, so that they cannot extend their compass at will. In the voice especially, although a few exceptional singers can, so to speak, acrobatise in music to the wonder of the public, yet the really good and usable part of even their compass for every-day work is comparatively limited, and if they are called upon frequently to sing either at their highest or lowest, the voice rapidly deteriorates, and wonder is changed to compassion. Violins even cannot afford to be "screwed up or down" too much, and rather prefer altering the thickness of their strings, with by no means a general improvement of effect. The thin strings are particularly objectionable in instruments only too prone to be played cuttingly. And clarinets and oboes, and even trumpets, when they are made short and narrow for high pitch, are only fit to be heard out of doors, as in military bands.

The whole secret of the difficulty lies in this: musical notes do not represent fixed and determinate sounds. The sounds collectively, when once the system of the scale is determined, are indeed fixed relatively to one sound, but that one has varied and does vary immensely. It has become quite an antiquarian problem to determine what sounds the writer of a piece of music attributed to his notes. This problem has to a great extent been solved by Mr. Alexander J. Ellis in a paper recently read before the Society of Arts and abstracted below, and we wish here to draw attention to the practical result of his labours.

Very little turns upon the music of more than three hundred years ago. It must be transposed, as is common with Orlando Gibbons's church music, and written in notes which at the current value will indicate sounds lying within the power of the singer. There is comparatively little of such music, and hence it is not difficult to reproduce it in the required form. It is only convenient to note in passing how very widely the meaning of the notes then differed from ours, Gibbons using a pitch which Mr. Ellis estimates as a whole Fourth above Handel's. But this does not apply to the great mass of classical music which has appeared since the beginning of the eighteenth century. When equal temperament (a babe of less than forty years old in England, as Mr. Ellis's facts establish) has a notation of its own, as has recently been proposed in Germany, and ceases to wear the clothes which Salinas designed in 1577, then it will become necessary to transcribe these works. In the meantime we must use what we have to the best advantage, and as much as it is possible in the sense which the composers intended. And what was that? The principal historical fact which Mr. Ellis seems to have established is that all over Europe, for two centuries, down to 1816 at earliest in Vienna, later in the rest of Germany and in France, and down to 1828 in England (taking the Philharmonic Concerts as the standard), the sound assigned to the tuning A did not vary above one-sixth of a tone above or below the value of Handel's own fork, now in the possession of the Rev. G. T. Driffield, Rector of Bow, and that hence this well-known fork represents the mean pitch of Europe for all classical music. What is that pitch? It is five-eighths of a tone below the pitch of the great concert organs at the Crystal Palace, the Albert Hall, and Alexandra Palace. When during a hot June or July day at the Crystal Palace on a Handel Commemoration the temperature, and hence the pitch of the organ, is driven up, Handel's music has to be sung three-quarters of a tone at least, sometimes a whole tone, higher than he imagined when he wrote it. The strain thus laid on the sopranos and tenors, especially in the choruses, is out of all reason, and the music, deprived of its proper fullness and richness, loses greatly in effect. Of course such a practice can only be excused on the ground of ignorance, and that is a plea which can no longer be raised after the proofs which have been adduced.

But what is to be done? Much music, considerably less in quantity, and perhaps in quality, if we except Mendelssohn's, has been written to a much higher pitch. Thus the celebrated Gewandhaus Concerts at Leipzig, representing Mendelssohn's pitch, were a whole semitone sharper than Handel's fork, as is shown by Mr. Ellis. Are we to destroy the new music for the sake of the old, as we now destroy the old for the sake of the new? Or are we to have two sets of instruments—two organs at the Crystal Palace and Albert Hall, or at least two sets of stops in the same case? Of course such ideas are wild, though not so wild as they look, for Dresden has two sets of instruments, and old churches (as the cathedral at Lübeck and the Franciscan Convent at Vienna) have two organs in different pitches, nay one German organ certainly had stops in two pitches differing by a minor Third. We have however no need to have recourse to such devices. The French Commission on pitch in 1858 has given a satisfactory answer to the question. It has settled a value for A nearly half-way between the old and the new, but, as is just, rather nearer to the old, and has fixed this pitch by a beautiful standard fork properly preserved in the Musée du Conservatoire at Paris, the only real standard of pitch in the world. This Diapason Normal is exactly two-eighths of a tone above Handel's fork, and about three-eighths of a tone below the Crystal Palace organ at mean temperatures, that is below our highest concert pitch. An important resolution was passed at Dresden in 1862 by eminent conductors (quoted by Mr. Ellis), saying that such "a lowering of pitch to the new Paris standard appears equally desirable and satisfactory for singers and for orchestra; that quality of tone would gain, the brilliancy of the band would not be lost, and the power of the singers would not be so severely taxed or strained."

The rise in pitch since 1816 has been the result of a series of accidents. Nothing approaching to scientific or musical thought appears in it. The most that can now be

done is to recognise its existence by adopting the French compromise. And, by the way, this is by no means French except in name, for in 1828 Sir George Smart, then conductor of the Philharmonic, adopted what was practically the same pitch in England, and the greater number of so-called Philharmonic forks sold down to thirty years ago gave the C of the later French pitch. It has left its impress, too, on numerous organs which during this period were tuned to "Smart's pitch," as it was then called. It is in fact a long tried English pitch, displaced only by accidental circumstances during Costa's conductorship of the Philharmonic. In France its use is universal, in Germany it was generally accepted, though a fresh rise is there perceptible, in Madrid it has lately been adopted, and even in Belgium, the only country in Europe which approaches the English heights of pitch, a recent commission reported in its favour for both concerts and military bands. Finally, the enormous inconvenience felt by singers accustomed to this pitch, when coming over for a London season or special concerts (as at the recent Wagner festival, according to Wagner's own statement), have induced the Covent Garden Opera to revert to it again this season, so that musicians will have an excellent opportunity of judging of its effect.

A strong argument usually brought against a change of pitch is the difficulty of getting new brass and wood instruments. The French pitch has now lasted long enough for good instruments to be made in it, and it is in fact more easy, out of London, to obtain instruments in that pitch than in any other. But considering that it was used in England and in France for about twenty years prior to 1850, and that the bands accommodated themselves to the gradual change then, there seems no reason why they should not do so now. Organs present a difficulty, but no mercy should be shown to them. Organs sharpen so much by temperature in a concert room crowded or lighted up, or in summer, that it is really inhuman to build organs that even at mean temperatures strain the voice of a singer of Handel to follow. They are essentially solo instruments. French pitch is the highest admissible pitch for organs which have to lead voices, and those which are sharper should be flattened forthwith. Church organs are even now usually constructed but a trifle sharper than French pitch. As for pianos, it is well known that the concert grand pianos improve in richness and quality of tone by being brought down to French pitch. It is a mere matter of stringing and tuning, not of construction.

Besides the importance of having a uniform pitch to the singer and the manufacturers of instruments, there is a theoretical advantage to the listener. With equal temperament when properly carried out, the relations of the intervals in different keys remain precisely the same, and the effect of change of key therefore is due to the change of pitch of the tonic and its related notes. When the ear is accustomed to one pitch it easily recognises the key. When the pitch varies from time to time and place to place, the sense of key becomes deadened and lost, and even the most experienced ears become confused. Hence, both theoretically and practically, uniformity of pitch is imperative. Practically an intermediate pitch between the old pitch of Handel, Haydn, Mozart, and Beethoven, and the new pitch of Mendelssohn, Costa, and Verdi, is the only one feasible to allow of both kinds of music being played by one organ or one band. And such a pitch is the French, the pitch of all French and most German modern music, the pitch in which the works of Wagner can alone be properly heard.

FARMING

Farming for Pleasure and Profit. Fourth, Fifth, and Sixth Sections. By Arthur Roland. (London: Chapman and Hall, Limited.)

THE publication of a work bearing such a title, naturally commands special attention at a time when farming is looked upon as anything but a pleasant and profitable business. Although it is evidently written by one practically acquainted with agricultural operations, a perusal unfortunately shows that it is very imperfectly adapted for meeting the needs of farmers in times of difficulty like the present. It has a great defect in its oversight of many of the improvements which have been introduced during the last twenty or thirty years, so much so, indeed, as to lead to a doubt whether there has not been a clerical error in the date of publication, and 1880 substituted for 1850.

The Fourth Section of this work is devoted to "Stock Keeping and Cattle Rearing." The economical production of pork is evidently one of the details of practice on which the author prides himself. He says, "Nettles grow in great profusion in our hedges, the somewhat sandy soil which chiefly prevails apparently being favourable to their growth. These I have all cut down with a bill-hook by one of the men, and they are brought to the pigstyes—unless we boil some up with other green stuff, which we do when they are young—and the pigs eat the nettles as freely as they will cabbages. My economical contrivances in this way, as may be expected, provoked the scorn of the labourers at first, and does at all times upon the occasion of a new man being engaged; but the success of the plan has been proved to demonstration, over and over again, to my old hands, who have got into my ways and system, and it is upon the adoption of these economical contrivances that the profits of farming mainly depend."

If this were true clean hedgerows are a great mistake, and uncultivated weeds have been sadly undervalued, hence, possibly, even the present depression in agriculture. But the author has evidently not acted upon the advice which he subsequently gives, for he says: "The old labourers of a district are often better acquainted with the peculiarities of the soil and other matters, the result of long observation, than the farmer himself; and although it is by no means necessary to act upon their advice, which would often mislead and cause ignorance and prejudice to reign instead of sound principles, yet there is often much that may be learned from them and turned to profitable account." Practical experience, whether obtained by the labourer or by the farmer, is undoubtedly of great value, and should be justly prized; but it is open to question whether the author has here shown that discretion which will not allow "ignorance or prejudice to reign instead of sound principles."

In dealing with our various breeds of cattle the author falls into some grievous errors; for example, he remarks

that the North Devon cattle "do not possess any particular qualities as stock animals for the grazier or feeder;" and in reference to the Hereford cattle, says: "They are seldom met with out of their native district; and . . . it is doubtful whether the partiality they have succeeded in exciting with some persons does not arise from unjustified preference." Rarely, if ever, has any writer upon agriculture expressed views on this subject with less judicial care than has been shown in these quotations. The Shorthorns, which are evidently the author's favourites, have undoubted merits and many staunch advocates, but they have no monopoly of those good qualities which distinguish our improved breeds of cattle; and thus throughout the world Herefords and Devons become competitors with the Shorthorns, and in many cases successful competitors.

The Fifth Section includes "the Drainage of Land, Irrigation, and Manures." The action of burnt lime in the soil is probably as commonly understood by those who have given any attention to the use of manures as the action of any one of our fertilisers. Instead of giving any distinct and useful information upon the subject the author contents himself by such explanations as the following:—"Upon sandy soils, which seldom abound to any considerable extent in vegetable matter, the mechanical action of the ('burnt') lime is to combine with the finer particles of the soil and thus give additional consistence to the staple of the land; attracting the moisture from the atmosphere, it causes it to be less liable to be hurt by drought in those seasons when the crops suffer so greatly upon sandy soils, exercising a cooling influence upon hot land, although the lime itself be hot and of a warm nature to a cold soil. Upon these dry soils, however, it is necessary to give liberal dressings of putrescent manures, for seeds could obtain no nourishment from either the lime or the sand."

Here then we have an extraordinary mixture of ideas, arising from the action of burnt lime being confused with lime which has not been burnt, as, for instance, when chalk or marl has been used. The author is fully sensible of the important influences of manures, for he remarks: "The whole subject of the proper application of manure is one of the most important departments of successful husbandry, as is generally acknowledged, yet, unfortunately, in only too many instances is it one that is very much neglected beyond the most ordinary system of 'rule of thumb,' followed according to the 'custom of the country' which may prevail in each shire." Surely no stronger plea could have been advanced for the author giving his readers some clear explanation of the action of various manures, so as to aid them in exercising their thoughts on the subject, rather than simply following "the custom of the country." In this respect the work is certainly very defective.

The Sixth Section deals with "the Labourer, Root-Growing, and Hops." Of the various suggestions given for the benefit of the labourer, the author certainly deserves credit for one novelty. He proposes that, "instead of allowing the men to keep pigs themselves, let the smallest out of a litter be given to each man as they come round—not the smallest pig that is born, for this particular pig would be found to thrive in a mysterious manner, so that he overtook and beat all the others—but the smallest when they are killed or sold. By this means all the pigs will make equal progress, and an arrangement of this kind will cause an extraordinary amount of interest in the various kinds of stock." We may certainly take it for granted that none of the labourers on the farm would have any objection to such an arrangement, but it is by no means equally obvious how the men who are attending to the horses, or engaged on the land, can contribute to the welfare of the pigs, except by contributions of corn intended for the horses, or by supplies of nettles from the hedgerows.

With curious inconsistency the author almost immediately after, in noticing the importance of a supply of milk, remarks, "The milk should be sold at a cheap rate, *not given*, so that the independence and self-respect of the labourer is preserved." In this latter recommendation we cordially agree; but is the larger gift of a pig of such a thoroughly substantial and consolatory character as to prevent any loss of self-respect? It would doubtless be a matter of rare occurrence, but however frequent it might be, if the master should find it consistent with the pleasure and profit of farming, the labourers would probably not complain at their independence being thus far overlooked. It is undoubtedly desirable to promote feelings of independence and self-respect amongst labourers, but we fail to detect in this section any indications of a definite policy likely to lead to this result.

The chapter on the growth of Hops is the most valuable of the entire series, and is quite a redeeming feature in the work. Nor must it be supposed that other parts of the several sections are devoid of merit; on the contrary, the work contains many valuable statements, which manifestly come from a mind practically acquainted with some of the subjects brought under consideration. It is however much to be regretted that these grains of good corn have not been more perfectly winnowed, so as to present a purer and more marketable sample to the public.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Mr. A. R. Wallace's "Australasia"

ALTHOUGH somewhat late in the day, I beg to offer a few remarks on this work supplementary to the critique which appeared in the columns of NATURE, vol. xx. p. 598. The facts that "Australasia" is the only compendious work which we have in English on the subject of which it treats, and that the high authority of Mr. Wallace's name will be equivalent with the majority of readers to a guarantee for the accuracy of the maps and letter-press, render it important that such errors as exist in the book should be rectified at once. For this reason I venture to make the following brief observations on those sections of the work treating of the Philippines and Borneo, with which districts I chance to be personally familiar.

1. In the map of the Philippines the islands of Sulu and Balabac, and the halves of the islands of Palawan and Mindanao, are shown as Mahometan native states, whereas they are all as undoubtedly Spanish possessions as is the interior of Luzon. In Barilan the Spanish have long had a naval station and arsenal; at Port Royalist they have a naval station and penal settlement; and the same at Balabac; and they have within the last few years firmly possessed themselves of the chief Sulu island. They

have also the settlements of Pollok and Cota Batu in Ilana Bay. The whole of the above-named places are in regular steam-communication with Manila.

2. In the map of the Malay Archipelago the geography of the north-west coast of Borneo is so inaccurate as to be quite valueless. The great Rejang River should run to near the head of the Koti, and therefore the Sarawak Territory be prolonged much further eastwards. The Limbang is brought down far into the Sarawak territory; and the Baram, a river nearly as large as the Rejang (up which I have myself steamed 200 miles), is entirely omitted. The Brunei Territory should extend as far as Marudu Bay. All the old errors in nomenclature which have long been corrected appear afresh. Considering Mr. Wallace's local knowledge, it is surprising that he should have inserted a map of Borneo which is quite the most inaccurate as regards the physical geography of the island of any that have come under my notice.

3. In the summary of the mammalian fauna of the Philippines (p. 272) only three species of insectivora are enumerated, the two quite distinct species of *Tupaia* inhabiting Palawan and Mindanao respectively being unnoticed. Speaking of the avifauna (p. 273), Mr. Wallace mentions the absence of pheasants as one of its negative characteristics—but he includes the Palawan group in the Philippines, and this group has *Polyplectron*. Mr. Wallace also states that there are deer in Palawan. It would be interesting to know on what authority this statement is made, for I believe that Dr. Steere and myself are the only naturalists who have visited Palawan, and to myself both Spaniards and natives strenuously denied that any kind of deer existed on the island. With regard to the observation that the Malayan indigenes have more or less frizzled hair (p. 293), I may remark that the only tribe with which I came in contact—the Tagbenûa of Port Royalist—were straight-haired. I inquired about a Negrito race, but could hear nothing of any in that part of Palawan. The Spanish capital of Palawan and residence of the Governor is Puerto Princesa (Port Royalist of our charts), not the older settlement of Taitay (p. 274).

4. Tibang Mountain in Borneo (p. 349) is by common report of the natives the source of the Rejang, Kapuas, Banjar-Masin, and Koti rivers. It is said to have a *white* summit. The rhinoceros (p. 354) is by no means confined to the head of the Koti river. It is quite common on the east coast of Borneo, in the Kinabatañgan valley especially, and is found also in the upper waters of the Kapuas and Rejang. Wild cattle can hardly be said to be confined to the northern part of the island. They abound in the Upper Rejang, are found on the shore near Bintulu, and have been seen as far west as Batang Lupar. There are possibly two species. They are certainly *not* the descendants of Spanish cattle, though these exist, and they may have interbred locally. At p. 356 Mr. Wallace writes: "The Dusun or Idâan tribes—the Kanowits and Pakatans—correspond to the Land-Dyaks of Sarawak, while the Milanows correspond to the Sea-Dyaks." This is a most extraordinary statement. Dusuns, Kanowits, and Land-Dyaks may correspond to one another—though this has yet to be demonstrated—but there are as radical differences in language, customs, and physical characters between Milanows and Sea-Dyaks as between any two tribes in North-west Borneo. Pakatan, by the way, should be written Bakatan (*bukit*, a hill).

5. I add a few notes on the Appendix. The Balow Dyaks (p. 629) people the Lower Batang, Lupar, and Liñgga rivers. There are only a few immigrants in Simunjon. The Sea-Dyaks of Borneo (p. 634) are clearly distinct from the Kayan tribes, as much so as they are from Milanows, who are related to the Kayans. The Sea-Dyaks have within the last thirty years become the dominant race of North-west Borneo, but the Kayan tribes seem to be decaying. The correct spelling of Ilanun (p. 637) is, I believe, Irânun (cf. Maludu = Marudu). It is worthy of note (p. 638) that the indigenes of Basilan style themselves Jakuns. The Idâan (p. 647) inhabit the vicinity of Kina Balu, but the Muruts the Padas and Limbang rivers, with intervening districts inland.

A. HART EVERETT

Papan, North Borneo

Nicholson's Palæontology, 2nd Edition, 1879

MAY I ask the favour of your inserting in NATURE the following remarks on the second edition of Prof. Nicholson's "Manual of Palæontology," which has but lately reached us in India.

First of all, I desire to express my sense of the obligations which are undoubtedly due by all palæontologists to Prof. Nicholson for the amount of labour which he must have expended in bringing together such an amount of facts as are contained in the work before us. Such a labour can be only fully appreciated by those who have experienced the difficulty of keeping pace with the discoveries even in one branch of the subject.

In a work like the "Manual" there must, almost inevitably, be many sins of omission, and some of commission, and it is accordingly with a full sense of the difficulties of Prof. Nicholson's task before me that I venture to point out certain errors and omissions in the part devoted to the palæontology of the vertebrata, and more especially in regard to India.

In his preface Prof. Nicholson observes that the greater part of the work was written in the early part of the year 1878, and consequently that his readers must not expect to find notices of discoveries made after that date. No one can, of course, take exception to that statement, but there are to be found in the text numerous omissions not covered by this saving clause, as will be seen from the following instances:—

The first point I have to notice is in relation to the Siwalik rocks of India. It was surely due to Prof. Nicholson's readers to know that those who had most recently studied the newer tertiaries of India were of opinion that the Siwaliks are in great part of pliocene, and the Narbuda rocks of pleistocene, age. Whenever Prof. Nicholson alludes to the latter, they are termed pliocene, while the former, except in two places, are termed upper miocene. I may add that these newer views as to the age of the rocks in question were published in India as far back as 1876.

Again, whenever any reference is made to the Siwalik fauna, no notice is taken of any of the additions made to it since Falconer's time, though many of them were published before 1878.

The succeeding remarks bear reference to some of the more striking of the omissions and errors occurring in the part of the work under consideration (vol. ii.).

P. 136.—When treating of the *Lepitosteids* no mention is made of the occurrence of several genera of this group in the Gondwána rocks of India, and of their being possibly older than their European representatives.

P. 169.—It would surely have been well to have made mention of the occurrence of three species of *Ceratodus* in the probably triassic rocks of India.

P. 209.—The Indian genus *Parasuchus* (as yet undescribed) ought to have been referred to, when mentioning the division Parasuchia, of which it is the type.

P. 222.—We find the sentence, "*Dicynodon* and *Oudenodon* are known only from strata of supposed triassic age in India and South Africa." The inference from the above would be that both genera occur in India, whereas the former only has been found there.

P. 256.—"In the miocene and pliocene tertiary we have no remains of *Cursores* to notice." *Struthio asiaticus* of Milne Edwards is ignored.

P. 300.—No mention is made of any fossil species of *Manis*, though one was described from India in 1876.

P. 324.—We again meet with the old statement as to the "hexaprotodont" character of *Rhinoceros sivalensis*, although it was shown in 1876 that there was no ground on which such statement could be supported.

P. 346.—No mention is made of the Siwalik species of *Sus*, nor of the peculiar Siwalik genus *Hippohyus*. The well-known and widely-distributed genus *Listriodon* is not mentioned in the book. The very peculiar genus *Tetraconodon* (described in 1876) is also omitted.

P. 348.—The genus *Anthracotherium* is stated to be exclusively European, no mention being made of the Indian species described in the "Records of the Geological Survey of India" for May, 1877.

P. 349.—*Hyopotamus* is stated to occur only in the eocene and lower miocene; the Sind species, described in the above-quoted paper, being unnoticed.

Pp. 379–80.—The dentition of the elephant seems to be a source of stumbling to Prof. Nicholson. He observes: "The first three teeth of the grinder series, which would ordinarily represent premolars, are supposed to be milk-molars, as they have no predecessors or successors." If any inference could be drawn from the above, it would be that the teeth in question were true molars; it is on quite different grounds that these teeth are classed as milk-molars. In the next sentence we find: "None of the molars, in fact, undergo vertical displacement," and immediately afterwards it is stated that premolars occur in

Elephas planifrons. In that species the premolars do vertically displace the milk-molars, as is shown in the "Fauna Antiqua Sivalensis."

P. 389.—*Dinotherium* is not mentioned as occurring in India, and *D. giganteum* is said to be the only species. Two species were named by Falconer in India!

P. 395.—We read: "The earliest remains of *Melidæ* are from the upper miocene deposits of the Siwalik Hills in India, in which we meet with the living genus *Mellivora* (comprising the Honey-Badgers), and the allied but extinct *Ursitaxus.*" *Ursitaxus* is not an extinct genus, but the generic synonym given by Hodgson for *Mellivora indica!* There is only one species of *Meidæ* from the Siwaliks, *Mellivora* (*Ursitaxus*) *sivalensis.*

P. 396.—*Ictitherium* is mentioned as occurring only in Attica, no notice being taken of the Indian species described in our Records for February, 1877.

P. 402.—*Pseudælurus* is only mentioned from Europe and America, the Siwalik species described in our Records for May, 1877, being ignored.

Other instances of omission occur in the book, which might be noticed here, but sufficient have been quoted to show that as regards Indian vertebrate palæontology, even up to the beginning of 1878, the work is not trustworthy. It is to be presumed that a writer would not willingly disfigure his own work, yet what can be said of a compiler who, in writing on Indian palæontology, omits to refer to the publications of the Geological Survey of that country. RICHARD LYDEKKER

Indian Museum, Calcutta, February 3

The Mean Free Path of Molecules

MR. CROOKES estimates that a bulb $5\frac{1}{4}$ inches diameter, attenuated 1,000,000-fold, would contain a trillion of molecules.

Assuming in round numbers such a space to contain 100 cubic inches, there would be 10,000 billions per cubic inch.

The molecules, considered as mathematical points, would have a mean distance apart of less than ·000005 inches.

The cube of 200,000 gives 8,000 billions instead of 10,000; therefore a linear inch would contain more than 200,000 in any direction.

How then can the mean free path of actual molecules be considered as from 2 to 6 inches? S. E. P.

The Zoological Station, or Aquarium, at Naples

WHEN, last week, you referred to the account in the *Daily News* of the above-named institution, you omitted what you probably did not know, which is, that, as you will see by the accompanying copy of a letter from Dr. Anton Dohrn to Dr. W. B. Carpenter, it was I who devised all the *aquarium* portions of the place, and that my ideas were carried out by the engineers, Messrs. Leete, Edwards, and Norman. But I had nothing to do with the *laboratory* part of the establishment.

We are now so accustomed to aquaria, as being useful adjuncts to biological studies, that it may surprise many persons to be informed that in the earliest published official notice of the Crystal Palace, Sydenham, a now very rare duodecimo of thirty-five pages, dated September 22, 1852, it is stated on pages 22 and 23 that, owing to the difficulty, amounting to what seemed to be impossibility, of exhibiting living marine animals inland, in sea-water, they, the fish, crustacea, mollusca, zoophytes, &c., would be shown dead, but, "*on a plan not hitherto tried, that of making them appear to be swimming in very large glass vessels containing a sufficient quantity of some preservative fluid having the appearance of water.*"

Something of this kind was attempted by Dr. Bowerbank, but it was not till the year 1870, after applying for fifteen years, that I, assisted by the same engineers, was permitted to arrange the aquarium now existing there, and which possesses the same sea-water, never since renewed, nor has it been changed in marine aquaria, which I set up in Paris in 1860 and Hamburg in 1862.

It is a pity that no one in Britain seems inclined to work our British aquatic animals, marine and fresh-water, as Dohrn exhibits and studies those of the Mediterranean and the rivers adjoining it; and British creatures of the same range of organisation, viz., sponges to fishes, are quite as interesting and almost as brilliant as those of the South of Europe.

We can, with modern appliances, possess these forms of life in perfect health, even inland, especially as recent improvements in manufacturing artificial sea-water causes it to be quite as good and as lasting as water from the sea. In Berlin and Hanover it has been so used for years on a large scale. In a small way it was employed long ago by Warington, Gosse, and by myself, and now, in the February, 1880, number of the *Midland Naturalist*, can be seen how wonderfully successful Mr. H. W. Jones has been with it in a great aquarium, in conjunction with me, in a place where water brought from the ocean would have cost more than six times as much. W. A. LLOYD

4, Zingari Terrace, Gipsy Road, Lower Norwood, April 6

Ice Crystals and Filaments

SOMETHING very like the "comb-like masses of ice" appears upon the surfaces of plaster-models such as dentists make, after they have been coated with a preparation called *Liquid Silex*; except that it is finer and *woolly*. It seems to be caused by the contraction of the models forcing out very fine jets of water or watery vapour, which dissolves the coating and spins it out until dried and fixed in the shape we find it. The varnish is readily soluble in water. S. T. BARRETT

Port Jervis, New York, U.S., March 20

Ozone

WILL you please allow me to make a suggestion concerning an additional element of observation at climatological stations? I refer to the observing of ozone. As the salubrity of a district to a great extent depends on this powerful factor, would it not be well to include ozone in climatological observations, especially in the case of hill and valley stations? The tests would, I think, at least enable *some* conclusions to be drawn as to the *purity* and *salubrity* of the atmosphere at the different health resorts, and in my opinion *present means*, even though imperfect, *should on no account be neglected* until better are found. They might be exposed on a hook in Stevenson's thermometer screen, as recommended by Mr. Buchan; but I find that this plan is only of service during dry weather, and I think Clarke's ozone cage is preferable. CLEMENT L. WRAGGE

Farley, near Oakamoor, Cheadle

Meteors

ON the night of April 4, between 10.5 and 10.25 p.m., I observed the following four meteors, viz.:—

1. Crossing the "Chair of Capiopœia," at an angle of 45° with the horizon, from the direction of *Ursa Minor*. Course about 20°, time about 2 seconds, leaving a train.

2. From 10° east of *Capella* to 10° below *Regulus*, nearly parallel with the horizon, passing below *Castor* and *Pollux* and above *Procyon*. Course about 80°, time about 5 seconds, leaving a train, and breaking up into several fragments before its final disappearance, the fragments travelling one behind the other in the same direction. I have never before seen a meteor of this kind with so long a course.

3. From 10° west of *Castor* and *Pollux*, to 5° west of them, leaving a train. The trains of these three meteors were all of the same bluish white colour. Their radiant points would probably be somewhere between *Ursa Minor* and *Cassiopæia*.

4. In exactly the contrary direction, just above *Castor* and *Pollux*. Course about 5°, leaving no train, or a very faint one.

Birstal Hill, Leicester F. T. MOTT

THE meteor described by your correspondent "B. W. S." was also observed by me at Bristol traversing a long path of 59° from 247° + 42° to 200° ± 0°. It was brighter than Jupiter, and travelled very slowly, the estimated duration being 7 or 8 seconds. The nucleus cast off a tail of sparks as it went along, and varied very perceptibly in brightness. At mid-course it seemed near extinction, but suddenly revived to its previous brilliancy, which was then sustained until near the end point.

A comparison of the meteor's track, as recorded at the two places, shows it to have been directed from a radiant near ψ Cygni (at 297° + 52°), and it is important to know whether any observations were made at additional places. The long duration of the meteor and its very conspicuous apparition in the evening sky must have brought it under the notice of a host of observers.

Ashley Down, Bristol, April 5 W. F. DENNING

Anchor-Ice

ON looking over some old papers I find a few notes on a rather curious instance of the mode of formation of anchor-ice which was accidentally brought to my notice.

When at Repulse Bay on the Arctic Circle many years ago, I went out one morning in the latter part of September to shoot deer, and on my way forded a stream of no great size, dry shod, having on Eskimo waterproof boots, the water being little more than a foot deep. The parts of this small river which had a slow current were already covered with ice, but not strong enough to bear my weight. For so early a date the day became extremely cold, and on my way home, after an absence of about eight hours, I was surprised to find, when recrossing the stream, that the water came high over my knees, filling my boots.

On examination I discovered that this rise of water was produced by an accumulation of *frozen water* fully eight or nine inches deep, adhering to the stones at the bottom of the rapid, all of which must have been formed, since the morning, at the rate of not less than one inch in the hour. The foot sank readily into this "slushy" formation, a lump of which rose buoyantly to the surface at each step.

Unfortunately I could not wait to study the process of construction as it was getting "dusk," and my wet clothes—which had to be cut off when I got to my fireless tent—began speedily to freeze.

I have seen "anchor-ice" in rivers many times, and believe that two or three conditions are requisite for its formation, namely:—

1. A rocky or stony bottom.
2. Shallow water as compared with that higher up the stream.
3. A swifter current and rougher water in comparison with a smooth and slower motion immediately above.

All these conditions existed in the present case.

The ford was a rapid, and as I have already mentioned, shallow, whilst immediately above there was a pool of nearly still water, three or four times as deep, which was ice-covered to within a few yards of the ford. On the surface of this almost still water, close to the rapid, where it was yet unfrozen, numerous small crystals of ice were forming and floating, indicating that the water was at—perhaps colder than—the freezing point.

When these ice-crystals and surface cold water get into the turmoil of the rapid, they are brought into contact with the rocks and stones at the bottom, which are thus cooled down to the freezing point, and become convenient nuclei for ice-formation.[1]

Supposed anchor-ice is often found at the bottoms of shallow lakes and ponds, and also in the quieter pools of rivers; but this, as far as my experience goes, is not true anchor-ice, but is formed in the usual manner, beginning at the surface and increasing in thickness *downwards* until it reaches the bottom, to which it freezes firmly and remains attached during the spring and early part of summer—perhaps longer—with two, three, or more feet depth of water over it, as it slowly thaws.

The manner in which anchor-ice is formed may be well known; if so, the fact that no satisfactory description of the process has come under my notice is the only apology I have to offer for troubling you with this communication. J. RAE

4, Addison Gardens, Kensington, W., March 25

[1] The way in which masses of ice, yards in extent, which have been floating on the surface in the smoother and slower current of a river, disappear when they enter a rapid and remain under water for some time, may be noticed in any country where the winters are cold enough, at the breaking up of rivers in the spring.

Diatoms in the London Clay

I REGRET to find that there are some beautifully mounted slides in circulation in London that have been sold, and are labelled as diatoms from the London clay, which are not what they purport to be. To prevent further disappointment to microscopists, will you allow me to say that arrangements have been made for slides of the London clay diatoms to be procurable shortly at any of the usual places? Due notice will be given by advertisement in this paper, when and by whom slides can be supplied to the trade. W. H. SHRUBSOLE

Sheerness-on-Sea

Carnivorous Wasps

IN NATURE, vol. xxi. p. 417, there is the statement that common wasps are carnivorous. I can prove this fact also by my own experience. I observed, one summer, in a country house, where wasps were shut in a room, that from lack of their usual food, and probably forced by hunger, they caught flies and devoured them. I saw several times wasps with a fly between their mandibles creeping on the window-glass, or eating them. Generally the wings and the head of the flies were mangled. I was one day so happy as to see a wasp catch a fly on the window, and observed how cleanly it picked the wings of the fly in order to hinder its flying away, and after having done so, how the wasp ate the head. I saw also some wasps quite prostrate and dying of hunger at last. I think that this fact could easily be verified by experiments. LEWIS BOD

Hungary, Stuhlweissenburg, March 20

TWO ENTOMOLOGISTS

THE brief notices that appeared in the *Times* and in our last number of the death of two of the most prominent Continental entomologists, were scarcely sufficient, and we therefore give a slightly more extended account of the lives and labours of both.

Ernest August Helmuth von Kiesenwetter, born in 1820, was a member of the Saxon Privy Council, and was highly esteemed in his native country. Although only sixty years old at the time of his death, his first recorded published paper dates so long back as 1842. He was one of the most accomplished and conscientious German entomologists, and one of the hardest workers—a considerable traveller, so far as entomological journeys in different parts of Europe are concerned, a close observer, and a man above suspicion as to the nature of his work. Though chiefly a coleopterist, he attended more or less to all orders of insects, but limited his studies principally to the European fauna. The greater part of his memoirs appeared in the *Stettiner entomologische Zeitung* and the *Berliner entomologische Zeitschrift*, and the list is very long. But his principal work is undoubtedly concentrated in the part he took in the "Naturgeschichte der Insecten Deutschlands," commenced by Erichson, and completed so far as the greater portion of the Coleoptera are concerned. How far Kiesenwetter's decease may render even this portion incomplete, and prevent the realisation of the original scheme, we know not. It was a grand idea with an unfortunate title. Few works on systematic entomology have rendered so much service to workers occupied on those groups already attended to, and it will remain a monument to the industry of all concerned. Its title has brought upon it the reproach of being a natural history in which there is no natural history, a severe criticism which a little forethought on the part of the originator should have avoided. Kiesenwetter had to assist in carrying out a set programme. He did his part of it well and faithfully, and his other writings prove that the biological side of the question was always prominently before him.

In S. C. Snellen van Vollenhoven Holland has lost its Westwood. He was born in Rotterdam on October 18, 1816, and not even his intimate correspondents here knew of anything likely to cut short the career of so prominent a man. Attached for many years to the Natural History Museum at Leyden as Director, he retired from that position a year or two ago, and so much was he respected that a medal was struck in his honour upon that occasion. Van Vollenhoven was a naturalist in the fullest sense of the term. It has been said of him that his principal work was his "Faune entomologique des Indes Orientales," meaning thereby (principally) of the Dutch Indies. This work was sufficient to base a reputation upon, but it was, from a biological point of view, not the most important. He occupied himself especially with the insects of Holland, and it is for the works he produced upon them that his memory will be everlastingly respected by Dutchmen, and by all other entomologists who think there is yet much to be done in working out the fauna of Europe. Indeed we fancy the exotic work was forced upon him by the necessity of his position, rather than done *con amore*.

He published a fine volume on the "Hemiptera-Heteroptera of Holland," finally in a separate form, but originally in the pages of the *Tijdschrift voor Entomologie*, the *Transactions* of the Dutch Entomological Society, of which he was the leading spirit. Through the same medium he offered a series of biological memoirs on the Dutch Saw-flies, probably unparalleled for completeness. He continued Sepp's "Beschrijvingen en Afbeeldingen van Nederlandsche Vlinders," which remains without an equal. And in the latter decade of his life he produced a remarkable work (now incomplete) on the Ichneumonidæ of North-Western Europe, under the title of "Pinacographia." No man was more universally esteemed when living; no man will be more thoroughly missed amongst entomologists. For Holland his loss appears to be irreparable.

In concluding this notice it should be remarked that all Van Vollenhoven's own works (and those of some other Dutch entomologists) were illustrated by beautiful and faithful drawings from his own pencil.

A LEAF FROM THE HISTORY OF SWEDISH NATURAL SCIENCE[1]

II.

SCHEELE was born at Stralsund on the 9th December, 1742, the fifth in order of a numerous family. His father was a merchant of limited means who did not intend to give a *learned* education to his son Carl Wilhelm, who besides, like Linnæus and Berzelius, is said in his youth to have shown so little disposition for the common classical school studies that he was in danger of being considered the stupidest among his fellows. The Stralsund gymnasium accordingly was soon exchanged for the post of pupil to the apothecary Bauch at Gothenburg. Here Scheele was not kept very long at servile drudgery and mechanical hand labour; his attention to his duties and industrious reading of approved chemical authors soon gained him a place in the laboratory itself, where he not only distinguished himself by steady application and special skill in the accurate making-up of the preparations which belonged to the establishment, but also experimented in the silence of the night in order to satisfy his curiosity. He had now come to the right school bench, and with an experience led astray by no learned theories for his teacher, he laid the foundation of the chemical views and of that skill in chemical manipulation which were to gain for him so famous a name in the history of the natural sciences.

After the close of his six years' apprenticeship Scheele remained three years more at Gothenburg, after which he was employed in an apothecary's shop at Malmoe. From Malmoe he removed three years after, in 1768, to Stockholm. According to Wilcke's statement Scheele had by this time made several important discoveries, without however having succeeded in obtaining any direct acknowledgment of the accounts of the experiments relating to them which he had communicated to the Swedish Academy of Sciences. He was not, besides, satisfied with the employment he had obtained in the capital at the apothecary's shop, "Korpen," because he had nothing to do with the laboratory work proper. He therefore removed in 1770 to Upsala, attracted by the famous name of Bergman, to undertake the charge of the laboratory at one of the large apothecary's establishments there.

During his stay in Stockholm Scheele had given in to the Academy of Sciences several chemical papers which, after having been submitted to Bergman, were not printed, and it is even supposed that the learned professor of Upsala did not think it worth his while to read the productions of the young apothecary. At first, therefore, a certain coldness is said to have prevailed between these two men, of whom one was, and the other was soon to be, recognised as one of the greatest scientific geniuses of the century. An accident however soon brought them together, and the coolness gave place to a mutual friendship and admiration, of which the writings of both, and numerous letters from Scheele to Bergman, preserved in the Library at Upsala, bear witness. These pleasant relations exerted a great and fruitful influence on the scientific activity of both. The sharp-sighted experimenter and discoverer, Scheele, required the support of Bergman's regard and comprehensive learning in order to win recognition, and Bergman's organising genius was brought by Scheele's discoveries in contact with new fields of research before untouched by any man of science.

While residing at Upsala Scheele published (1770-75) some of his most important researches, for instance, on fluor spar, on black oxide of manganese, on arsenious acid, on the composition of the air, &c., and thus gained for himself almost at once a great reputation, not only in Sweden, but also in foreign countries. He was soon after chosen a member of the Swedish Academy of Sciences, in whose circle he took his place on an equal footing with the first men of the realm. From this time the young chemist was honoured by this scientific association in a way that always will form one of its fairest memories, and which under similar circumstances could scarcely have happened to him so early in any other country,—a circumstance which shows that no credit is to be given to the story which has been repeated in several of the sketches of his life, that Scheele was so little known to the leading scientific men of Sweden that a distinction intended for him by Gustavus III. was by mistake conferred upon another person of the same name. On the other hand it may have been true, and if so, it showed the little interest that Gustavus III. and his court entertained for Swedish natural research, that the King of Sweden on the 21st March, 1784, while present at a meeting of the Turin Academy of Sciences, for the first time heard the name mentioned of the only person with a truly world-historical name who then lived in Sweden. Little also does he appear to have suspected that in his own capital there was an Academy which, in respect of the influence it exerted on the progress of natural research, occupied a position quite equal to that of any other academy whatever.

From 1777 Scheele obtained from the Academy an annual grant of 100 rixdollars specie (about 40 guineas), to assist him in carrying on his chemical researches. He was present however at the meetings of the Academy only once, on the 29th October, 1777, when on his admission he read a paper "On a method of preparing *Mercurius dulcis* in the wet way." The day before he had undergone the apothecary's examination at the Medical College, and after taking the oath obtained an open commission empowering him, on the invitation of the magistrates, to be apothecary in the town of Köping.

For the longing for an independent sphere of activity had led Scheele in the autumn of 1775 to leave Upsala and remove to Köping, in order as dispenser to take charge of the apothecary's shop there, which belonged to a young childless widow of the former owner. From this time Scheele's life flowed calmly on in this town, uninterrupted by any remarkable occurrences, if we except a passing cloud caused by a buyer presenting himself with an offer to purchase the apothecary's shop of which Scheele had charge. This gave occasion to numerous proofs of friendship and regard for him. Gahn proposed that he should remove to his house; Bergman offered him a place at his table till some other suitable employment should turn up. Linnæus, Wargentin, Bäck, Schultzenheim, Alströmer, and the brothers Bergius offered him an apothecary's shop with a suitable laboratory and several advantages at Alingsos. Others wished to instal him as *Chemicus regius* in the capital and make him director of a new distillery. On D'Alembert's proposal

[1] Translated from a paper by Prof. A. E. Nordenskjöld of Stockholm. Continued from p. 521.

he had been invited to Berlin and promised a salary of 1,200 rixdollars specie, and attempts were made to induce him to go to England by a promise of £300 a year, which foreign offers Scheele however declined, with the saying which indicates his modest requirements as to his mode of life, "I cannot do more than eat my meat; if I can do that at Köping, I need not seek it elsewhere." He was soon freed from the trouble of choosing, by the townsmen of Köping and the gentry of the neighbourhood declaring that the town would not have any one else than Scheele as apothecary, and offering in case of need to obtain privileges and build a new apothecary's shop for him. The matter was thus settled to Scheele's advantage. He was allowed to retain his place as manager of the apothecary's shop at Köping till his death, which happened on the 21st May, 1786, after some months' illness, probably brought on by constant work in cold laboratories with substances poisonous and injurious to health. Three days before his death he married the widow of the former apothecary, Fru Sonneman.

In the town house at Köping is preserved the inventory taken at the death of the great departed chemist.[1] It gives us indeed an insight into the modest circumstances in which he lived, but it indicates economy and the possesion of some means, and shows that the glory of poverty, with which some biographers have sought to surround Scheele's memory, by no means corresponds with the actual facts. As indicating the scantiness of the literary assistance within Scheele's reach, it deserves to be noted that at his death, after a stay of more than ten years at Köping, he only possessed a collection of books consisting of twelve works on medicine and chemistry, with several other Swedish, German, and French books, valued at 6 spec. (26*s*.)

Scheele was described as a man of moderate height and of a powerful frame. His modest manners and his genuine worth speedily won for him the friendship and affection of all with whom he came in contact. He appears to have prospered most at Köping, whose inhabitants entertained for him great regard, mingled with admiration at the experiments and researches, to which he devoted all the time he could spare. The memory of the distinguished man is still preserved in the town. There they tell you that the stone lion, which forms the sign of the apothecary's shop, had been gilt by Scheele so well as never to require renewal, that Scheele made a vane to the steeple, a sun, with rays pointing in many directions, which protects it from lightning without any lightning conductor; that Scheele tried to make gold, and with that end in view worked much with Spanish green, which brought about his death, &c.[2]

When Scheele died he had not completed his forty-fourth year. A great part, perhaps the greater part, of his short life-path had been constantly occupied with earning a living, and for a complete exhibition of the influence he exerted it would not be enough to go leaf by leaf through the field of chemical research. We must also take note of the development of chemical physiology, of pharmacy, and above all of the whole of the industrial arts of recent origin, for on all these branches of human knowledge his genius has impressed an ineffaceable stamp. Here we can only give a short sketch of his most important discoveries.

Scheele's first work of which we have any knowledge, "Chemical Experiments with Sal Acetosellæ," was given in to the Swedish Academy on the 17th of August, 1768.

[1] The inventory shows:—Assets, gold and silver, 61 spec.; tin, 10 spec; glass and porcelain, 11 spec.; other movables, 187 spec.; apothecary's shop, 667 spec.; goods in apothecary's shop, 175 spec.; real property, 500 spec.; open accounts, 100 spec.: total 1,711 spec. (about 376*l*.). Against this sum there are indeed debts amounting to 630 spec., but if proper attention be given to the economical state of Sweden at that time, Scheele must have been considered by his contemporaries a man in comfortable circumstances.

[2] A story which probably originated from the manufacture of a large quantity of "Scheele's green."

It was read to the Academy, but not printed. Two years after we find for the first time Scheele's name in the *Transactions* of the Academy, in a paper by Anders Johan Retzius, in which he states that Scheele, a *Pharmacie Studiosus*, of good abilities and eager to learn, had succeeded in producing from tartar, by means of chalk and sulphuric acid, a clear and pure acid. To judge by the title and some remarks of Gahn's, it appears that the first-named work contained a fundamental discovery in organic chemistry, viz. that of oxalic acid. The discovery of tartaric acid formed a further important step forward within the same branch of knowledge, and was besides of epoch-making significance through the new method which Scheele here for the first time employed in producing the acid. The same method is still used in similar operations, and in Scheele's skilful hand formed the means by which he separated and ascertained the properties of a number of other organic acids occurring in animal and vegetable juices, as citric, malic, and lactic acids, all substances before unknown, or of whose true nature the knowledge was very obscure and erroneous. By other experiments and researches, which were always simple and went straight to the mark, Scheele enriched the chemistry of animals and plants with the discoveries of uric acid, gallic acid, and glycerine. It lies beyond the scope of this paper to give an account of the great importance of these discoveries, not only for theoretical chemistry, for medicine, and animal and vegetable physiology, but also in a purely technical point of view. Only as an instance, we give here some notes of the technical history of glycerine.

While engaged in some pharmaceutical work, Scheele found that by heating oils and animal fats with oxide of lead it is possible to extract from them an uncrystallisable substance with a sweet taste, which, like common sugar, when treated with nitric acid yields oxalic acid. On this account he named the new substance oil-sugar—a name afterwards changed to glycerine. As usual Scheele carefully ascertained the chemical properties of the new substance, yet without carrying out the research by investigating the nature of the ingredient of the fatty matter which combines with the oxide of lead. This was not done till about thirty years afterwards, when Scheele's research was resumed by Chevreul, who, starting from Scheele's observations, after twelve years' hard work, cleared up the true nature of the animal fats and showed that they contain, along with glycerine, various fatty acids which with alkalies form soap, and one of which, under the name of *stearine*, has since been extensively used as light-yielding material. It is on this research that the modern soap industry and the manufacture of stearine candles, &c., are grounded. Glycerine, too long neglected as a useless by-product, has obtained a manifold practical application, not least in Sweden, where, as is well known, it now forms the raw material of one of our most important explosives, a main constituent of aseptine, &c.

By these researches in a field of investigation in which Scheele had scarcely any predecessor, he was the true founder of our chemical knowledge regarding the productions of organic nature, for the further development of which hundreds of professorships have been established, and which has long since become of incalculable importance for the intellectual progress and economical advantage of the human race. This field of inquiry he further enriched by the examination of a number of ethers, and above all by his "Research on the Colouring Matter of Berlin Blue." A brief historical sketch may perhaps here also be of interest.

In the beginning of the eighteenth century Diesbach, a German dyer, along with the alchemist Dippel,[1] accidentally discovered the beautiful blue colour which is known under the name of Berlin blue. The discovery, which supplied a

[1] German alchemist and mystic, died 1734.

long-felt want of a good and cheap blue colouring matter, was at first kept secret, till the process of preparation was published in a paper in the *Philosophical Transactions*, 1724, by Woodward. Afterwards a number of chemists attempted to ascertain the true nature of the colouring matter, but without any further success than that improvements were made in the process of preparation, and some new substances were discovered, into the composition of which the colouring principle entered as a constituent—among which as the most important may be named the yellow prussiate of potash discovered by Macquer in 1752. In 1772 Sage still believed that phosphoric acid entered as a constituent into the composition of prussiate of potash, and in 1786 Westrumb declared the colouring matter to consist of a volatile phosphor-soap. Two short papers by Scheele, together occupying not more that twenty-two pages of the *Transactions* of the Swedish Academy of Sciences for 1782 and 1783, at last brought clearness into this confusion. Scheele showed that the origin of the colouring power was a peculiar volatile acid (blue acid), whose properties he accurately ascertained, and of which he produced many new and important compounds. Scheele, besides, showed that the acid contained carbon and nitrogen, and that when subjected to combustion it gives off carbonic acid, and to dry distillation ammoniacal salts among others. On the other hand, Scheele is thought not to have suspected that the substance which, without any special precautions, he produced in considerable quantity, smelled and tasted, forms one of the most powerful poisons with which we are acquainted. The work thus begun by Scheele was carried on by later chemists (Porret, Gay-Lussac, Berzelius, Faraday, Gmelin, Wöhler, Liebig, &c.), and it is perhaps not too much to say that the accurate knowledge we have thus obtained of the nature of the compounds of cyanogen has exerted an influence on the development of chemistry only inferior in importance to that of the discovery of oxygen and chlorine.

We find the first printed work of Scheele in the *Transactions* of the Swedish Academy of Sciences for 1771. It bears the title, "On Fluor Spar and its Acid." Among the treasures which Pompey brought with him to Rome after his victory over Mithridates are enumerated goblets and cups of a beautifully-coloured fragile mineral, which, from the town at the plundering of which they were first obtained, were named *Vasa myrrhina*. They soon became fashionable, and Pliny and other writers speak of the fabulous sums that were paid and the bloody deeds that were done in order to obtain them. Among all the different objects belonging to Ancient Rome preserved in our museums, there is not, remarkably enough, a single fragment of these vessels so renowned in the history of luxury; but it has been guessed that they were made of a mineral which is now called fluor spar, and is still occasionally used for vases and cups. In mineralogical literature proper this mineral is first mentioned by the Saxon Agricola, who speaks of its use as a flux in the smelting of metals, and warns against mistaking this beautifully-coloured, but brittle and by no means hard mineral for a precious stone. Somewhat more than a century afterwards the art of etching on glass by means of this mineral was discovered at Nürnberg, and about the same time Elsholz, a Berlin physician who employed himself in the examination of phosphorescent substances, discovered that fluor spar became self-luminous when heated. All substances that are self-luminous without sensible combustion attracted at that period immense attention—certainly a survival from the alchemists' dreams about the philosopher's stone, which, among its other perfections, was also to have that of being self-luminous. The mineral, in consequence of its property of being a "light-bearer," now became the object of repeated but rather resultless examinations, until Scheele, by some simple experiments both analytic and synthetic, showed that the mysterious substance consisted of "lime saturated with a peculiar acid." This acid attacks glass and dissolves with ease siliceous substances. Scheele at first employed glass-vessels in producing it, which gave occasion to erroneous statements. The mistakes were immediately acknowledged and corrected when Scheele's attention was drawn to them by the apothecary Meyer of Stettin. Unwarranted objections, for instance by the Frenchman Boulanger, who declared that fluoric acid was nothing else than muriatic acid combined with some earth, and by Monnet, who believed that fluoric acid was only vitriolic acid "volatilised by means of a singular combination with fluor spar," were on the other hand refuted by new experiments in a paper printed in the *Transactions* of the Swedish Academy of Sciences for 1780. Scheele's examination of fluor spar had as its direct result the discovery of the simple substance *fluorine*, which without doubt, through its general occurrence in nature, and its properties differing from those of all other simple substances, is destined to play a very important part in the development of chemistry, although our knowledge of it is yet very incomplete from the impossibility of procuring vessels capable of resisting its corroding action.

(To be continued.)

ON THE LONG PERIOD INEQUALITY IN RAINFALL[1]

1. IF it be true that there is a variation in the power of the sun depending on the state of his surface, this variation might naturally be expected to make itself apparent through a corresponding change in the rainfall of the earth, so that when the sun is most powerful there ought to be the greatest rainfall.

2. While the connection indicated above is that which most readily occurs to the mind, yet the difficulty of ascertaining the facts of the case in a manner bearing the smallest approach to completeness, is so great as to be at present insuperable.

There is, *first of all*, an intense reference to locality in rainfall, so that the rainfall at one place may differ greatly from that at another place in its near neighbourhood.

Again, there are, probably, in addition to possible secular inequalities, very great oscillations in the yearly rainfall at any one place, or accidental variations as we may term them, in our ignorance of their cause.

Thirdly, it is in comparatively few places, and those places chosen not with the smallest reference to this particular problem, that we have anything like a trustworthy account of the rainfall throughout a considerable number of years.

Fourthly, we have no information of any importance with respect to the rainfall at sea.

3. Besides the formidable catalogue of difficulties now mentioned, we ought to bear in mind the following considerations. The convection currents of the earth are regulated by two things, one of which is constant, while the other may be variable. The constant element is the velocity of rotation of the earth on its axis, while the element of possible variability is the power of the sun. Hence it follows that if the sun be variable it will cause a variation in the direction as well as in the intensity of the earth's convection-currents on the principle which tells us that the resultant of two forces, one constant and the other variable, must vary both in magnitude and direction.

Now if it be true that we have a long period variation, not merely of the intensity, but also of the distribution of the earth's convection-currents, and if we bear in mind the intensely local reference in rainfall, it would be too much to expect that the rainfall inequality should exhibit the same years of maximum and minimum at all places.

[1] By Balfour Stewart, LL.D., F.R.S., Professor of Natural Philosophy at the Owens College, Manchester. Being a paper read before the Lit. and Phil. Society of Manchester.

It is even conceivable that some places might exhibit a maximum when others showed a minimum, while others again might exhibit a double instead of a single period.

4. It appears to me that if we bear in mind these considerations, it will not answer to add together the rainfalls of a few selected stations as they stand, with the view of determining by this means whether there be a long-period inequality in the rainfall of the *whole earth*. We are not yet in a position to reply experimentally to this question.

It does not, however, follow that nothing can be done. Dr. Meldrum and others appear to have achieved good preliminary work in the direction of indicating the existence of a rainfall inequality depending upon the state of the sun. Dr. Meldrum began by pointing out that in a good many places there is a greater rainfall during years of maximum than during years of minimum sun-spots, and that this phenomenon repeats itself from one solar cycle to another. Again, Governor Rawson has pointed out the existence of certain localities where the rainfall inequality appears to be of a precisely opposite character, while Dr. Hunter has shown the practical importance of the investigation with reference to certain tropical stations. The subject has likewise been discussed by Piazzi Smyth, Stone, and others.

5. The question has arisen whether it might be possible to throw any light on this problem by the method of deducing unknown inequalities proposed by Mr. Dodgson and myself (see *Proceedings* of the Royal Society, May 29, 1879). The essence of this method consists in a way by which we may numerically estimate the indications of an equality. Let us suppose, for instance, that in ignorance of the diurnal range of temperature we try to find whether there be a temperature inequality of twenty-four hours, or whether there be not rather one of twenty-six hours. We should begin by taking a large number of hourly readings of temperature, and we should group these into two series, the one containing twenty-four numbers in each horizontal row, and the other twenty-six. We should thus have twenty-four vertical columns from the one series and twenty-six from the other, and we should take the mean of each vertical column of each series, as well as the mean of the whole. Now it would speedily be found that an inequality was indicated by the twenty-four hourly series, and none by the twenty-six hourly series. For in the first series the mean of that vertical column representing observations at 5 A.M. would be greatly less than the mean of the whole, while the mean of that column representing observations at 2 P.M. would be much higher than the mean of the whole. On the other hand, in the twenty-six hourly series, provided it were sufficiently extended, we should perceive no such differences. Thus, in the twenty-four hourly series the differences of the means of the various vertical columns from the mean of the whole would be much greater than in the twenty-six hourly series, and the mean amount of these differences might be taken to form a numerical criterion of the presence or absence of an inequality.

6. This method applied to the subject in hand might be expected to reveal the presence or absence of inequalities in rainfall, provided we have observations sufficient for the purpose. It is clear that the successful application of this method does not require a previous knowledge of the exact form of the inequality. Whether a maximum rainfall occur at epochs of maximum or at epochs of minimum sun-spot frequency, whether there be only one rainfall maximum corresponding to the solar period, or two, or even three, is a matter of no consequence as far as this method is concerned. All that is necessary is that the rainfall should always be similarly affected by similar states of the sun.

Here, however, we must bear in mind that this method of detecting inequalities by summing up and averaging the departures from the mean caused by the inequality, likewise sums up and averages the accidental fluctuations. Now these accidental fluctuations are particularly large for rainfall, and it is therefore desirable to lessen their disturbing effect as much as possible. This can only be done by confining ourselves to long series of observations in which the accidental fluctuations may be supposed to counteract each other to a great extent, while the long period fluctuations will remain behind.

7. Through the kindness of Mr. Whipple, Director of the Kew Observatory, I have received copies of those catalogues of rainfall which he has himself made use of in a paper which was recently communicated to the Royal Society (January 8, 1880). Of these Paris, Padua, England, and Milan form the most extensive series, that of Paris embracing 161 years, Padua, 154, England (Symons's table), 140, Milan, 115. Mr. Whipple has likewise furnished materials by which the labour of applying the process in hand to these series will be greatly abridged, and he has kindly allowed me to make use of these. I will therefore apply the process to these four stations.

8. Let us begin by grouping the Paris yearly values into series of 8. We thus obtain the following final numbers (in centimetres):—

$$51{\cdot}4,\ 47{\cdot}5,\ 45{\cdot}7,\ 48{\cdot}7,\ 51{\cdot}1,\ 49{\cdot}8,\ 46{\cdot}5,\ 47{\cdot}2,$$

the mean being 48·5. From this we obtain the following series of differences :—

$$+2{\cdot}9 - 1{\cdot}0 - 2{\cdot}8 + 0{\cdot}2 + 2{\cdot}6 + 1{\cdot}3 - 2{\cdot}0 - 1{\cdot}3.$$

In order to diminish the effect of accidental fluctuations, let us equalise this series of differences by taking the mean of each two. We thus obtain

$$+0{\cdot}8 + 1{\cdot}0 - 1{\cdot}9 - 1{\cdot}3 + 1{\cdot}4 + 1{\cdot}9 - 0{\cdot}4 - 1{\cdot}7.$$

If we now add these together, without respect of sign, and divide by their number (8), we obtain 1·3 as the mean departure from the mean of the whole, and bringing this departure into a proportional shape by dividing it by the mean rainfall, we obtain $\frac{1{\cdot}30}{48{\cdot}5} = 2{\cdot}68$ per cent.

9. These explanations will enable the reader at once to perceive the principle of construction of the following table :—

Name of station.	Proportional rainfall inequality as exhibited by series of 8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.	14 yrs.
English rainfall, Symons's catalogue	2·63	2·14	1·55	1·79	3·15	1·69	2·57
Paris ...	2·68	3·07	1·99	2·65	3·70	2·57	3·08
Padua ...	1·77	3·62	2·02	1·47	3·31	3·52	3·40
Milan ...	1·12	3·22	3·16	1·78	4·13	3·78	2·49

We ought to give the English, the Paris, and the Padua observations a somewhat higher weight than those of Milan, as the former embrace a longer period. This will be done sufficiently well by giving the first three sets weights of 3 each and the Milan set a weight of 2. If we perform this operation, and then take the mean of these stations, we obtain as under :—

	Proportional rainfall inequality as exhibited by series of 8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.	14 yrs.
Mean of the four stations weighted as above	2·15	3·00	2·09	1·94	3·52	2·81	2·92

A maximum corresponding to nine years and a still greater one corresponding to twelve years is thus exhibited, each of these being recorded at three stations out of four.

The proportional numbers indicated are not large, but it must be remembered that it is the mean difference for all the years that is given, and that the maximum and minimum rainfall will represent differences above and

below the mean which will each be about double of the numbers recorded above.

10. Regarding the rainfall values as representing the meteorological result of the sun's action, let us now compare these with declination range values, which may be taken to represent the sun's magnetic effect. Prof. Loomis has compiled (*American Journal of Science and Arts*, second series, vol. l. p. 153) what seems to be a very good table, exhibiting a set of yearly values of magnetic declination range, extending with slight breaks from 1777 to 1868.

Let us take this table, and treat it precisely as we have treated the rainfall, except that it does not seem necessary to make any attempt at equalisation, such as that made in Art. 8.

We thus obtain the following result:—

Name of station.	Proportional declination range inequality as exhibited by series of 8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.	14 yrs.
Prague, or reduced to Prague	3·37	3·39	10·07	4·66	9·33	4·09	4·98

Here we have unmistakable maxima corresponding to ten and twelve years. The result is thus not unlike that which we have derived from rainfall observations; indeed we could hardly expect a more perfect correspondence between the two, bearing in mind the limited amount of observations which we have for determining inequalities of long periods.

DEEP-SEA DREDGING AND LIFE IN THE DEEP SEA[1]

As Dr. Carpenter explained in his lecture here some short time ago, four-elevenths, or nearly three-fourths of the surface of the earth is covered by sea. The average depth of the ocean is, according to the latest calculations of Mr. Otto Krummell, about 1,877 fathoms, or somewhat over two miles, very nearly the distance from the Royal Institution to the top of Primrose Hill. If we try and project Primrose Hill directly under our feet, keeping the distance the same, we shall form a conception of the mean depth of the sea. The greatest depth known to exist was discovered by the United States ship *Tuscarora* near the Kurile Islands, in the North-east Pacific. It is 4,655 fathoms, or about five miles and a quarter.

The highest mountain existing is of about the same height as the deepest sea is deep. Mount Everest is 4,833 fathoms in height. So insignificant, however, is the total volume of the land raised above sea-level in proportion to the vast cavity occupied by the sea, that were this cavity emptied of its water, the whole of the land now above sea-level could be shovelled into it twenty-two and a half times over before it would be filled up to the present sea-level.

Nevertheless the depth of the oceans, great as it is, is as nothing in comparison with the vastness of their extent of surface. As Mr. Croll has said, the oceans in relation to their superficial area are as shallow as a sheet of water 100 yards in diameter and only an inch in depth.

The sides of the ocean-basins are not at all steep. They are mostly so little inclined that an ordinary locomotive engine could run up them in a straight line with ease. Their inclination is usually not more than three or four degrees or less. Around some oceanic islands the slope is greater. The steepest slope known is, as Capt. Tizard informs me, at Bermuda, where there is an inclination of nearly twenty degrees from the edge of the reef to 2,000 fathoms. There are no such things as mountains and valleys on the deep-sea bottom. Animals cannot slip down against their will into the depths, but must move deliberately into them, and travel a long journey to reach them.

The pressure exerted by the superincumbent water at great depths is so great as to be almost beyond conception. It amounts roughly to a ton on the square inch for every 1,000 fathoms of depth, about 166 times as much as the pressure to which we are subjected at the present moment. At the greatest depths the pressure is about four tons and a half. Vast though this pressure is, it is, however, only about one-eighth of that which Prof. Abel and Capt. Noble have measured, as produced in their experiments on gunpowder. The deep-sea animals, being completely permeated by fluids, are probably no more conscious of pressure acting upon them than we, and, so long as they move slowly from one depth to another, are most likely unaffected by the consequent changes of pressure.

With regard to the temperature of the deep-sea water, the conditions which would affect animals are comparatively simple. Nearly all over the ocean the temperature at 500 fathoms is as low as 40° F., and this is the case even immediately under the equator in the Atlantic and Pacific Oceans. Below 2,000 fathoms the temperature is never more than a few degrees above freezing-point, excepting in the peculiar cases of land-locked seas, such as the Sulu Sea.

Fig. 1.—Japanese dredge in action.

At comparatively small depths in the sea it is almost certainly entirely dark so far as sunlight is concerned. Prof. Forel found that in the Lake of Geneva, even at a depth of only 30 fathoms, photographic paper was entirely unacted on after protracted exposure. We can hardly believe that the red, green, or yellow rays can penetrate sea-water much further than those to which ordinary photographic paper is sensitive. It may safely be assumed that sunlight is entirely absent at a depth of 200 fathoms, probably at a much less depth. We dredged blind crustacea at a depth of 120 fathoms, and a blind isopod is found in the Lake of Geneva at a depth of about 55 fathoms.

In depths of 500 fathoms almost everywhere, everywhere in over 1,000 fathoms, there must be an entire absence of any currents in the water. Any movement taking place in the water at that depth must be of a molecular nature only, excessively slow and quite imperceptible to animals.

Altogether the deep sea, cold, dark, and still, must b about the slowest place to live in that can be imagined.

I now turn to the consideration of deep-sea dredging.

The dredge is an ancient contrivance of fishermen of a very wide distribution. It is used in Japan, and the accompanying amusing figure (Fig. 1) is taken from a woodcut in a Japanese book on the principal land and marine food products of Japan. In it a fisherman is

[1] Friday Evening Lecture delivered at the Royal Institution on March 5, by H. N. Moseley, F.R.S., Assistant Registrar of the University of London.

shown quietly smoking his pipe whilst his dredge tows astern catching bivalves (either a Cardium or a Pecten). For the sake of clearness the artist has represented the dredge as partly raised out of the water. On the margin is the description, which my friend, Mr. F. V. Dickins, has translated for me. The dredge is described as a basket net which is dragged from the stern of a boat scratching up sand and mud and the shell fish. The particular shell fish here being caught are explained to have been formerly considered poisonous, and it is said that they are even now not considered very good, and are never used in gentlemen's kitchens.

A great step in advance was made on board the *Challenger* in the introduction by Sir George Nares of the trawl-net as a substitute for the dredge in deep-sea investigation. Still both the sounding and trawling apparatus used on board the ship were very imperfect in comparison with the apparatus now employed. Mr. Alexander Agassiz, following Sir William Thomson's improvements in methods of sounding, has introduced the use of wire rope for trawling with, instead of the hempen rope which we used. The wire rope has most important advantages. It occupies only one-ninth of the space of the hempen rope on board the ship, being only one inch and a sixteenth in circumference. It is of galvanised steel wire with a hemp core. It is not as big as my little finger, and contrasts favourably with the large trawl ropes of the *Challenger*. The wire rope is heavy in the water, and need not be weighted when in use like the old rope. Moreover it can be let run out and be wound in at such a rate that three or four hauls can be got in one day in depths over which the *Challenger* consumed a whole weary day for one haul.[1] Mr. Agassiz has also improved the trawl-net. Our trawl was an ordinary beam trawl which might fall on its back on the bottom and be towed along in vain. This

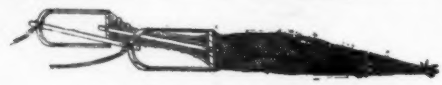

FIG. 2.—Mr. A. Agassiz's deep-sea trawl.

one is, as will be seen from Fig. 2,[2] reversible. It has two beams instead of one, as in the old pattern, and these are fixed to the irons midway between the two margins of the mouth of the net, one of which will scrape the bottom on whichever side the trawl may fall. Mr. Agassiz has also used with great success a simple iron bar with twelve or fifteen swabs fastened on to it, and towed in a transverse position. With this machine he brought up on one occasion no less than 124 specimens of two large species of Pentacrinus at one haul.[3]

I pass now to the consideration of life in the deep sea. As Prof. Weismann of Freyburg well said in a lecture on the animal life of Lake Constance,[4] "The sea is the birthplace of all animal and plant life; from it animals and plants have spread themselves on the land and into the freshwaters which permeate it." This birthplace of the various forms of life lay, no doubt, in shallow water on the coasts, and thence has taken place the colonisation of the deep sea on the one hand and of the land on the other.

It is only animals, however, which have made their way into deep water. The absence of sunlight at great depths is entirely prohibitive of the existence there of plants. As far as I observed, we did not dredge any sea-weed in the *Challenger* Expedition from a greater depth than 33 fathoms. Edward Forbes, however, found ordinary sea-weeds in the Ægean Sea down to a depth of 79 fathoms,[5]

[1] A. Agassiz: "Dredging Operations of the U.S. Coast-Survey Steamer *Blake*," *Bull. Mus. Comp. Zool.* vol. v. No. 1, p. 7.
[2] *Ibid.*, vol. v. No. 6. [3] *Ibid.*, vol. v. No. 14, p. 296.
[4] Aug. Weismann, "Das Thierleben im Bodensee," s. 5. (Lindau: Stettner, 1877.)
[5] Brit. Ass. Report, 1844, p. 165.

though they were very scarce at that depth, and may possibly not have grown there, and Dr. Carpenter dredged Corallinaceæ in abundance in 150 fathoms in the Mediterranean.[1] The question of the exact limit of the different species cf sea-weeds in depth, and of the absolute limit of plant-life altogether in the sea, is one of great importance, and which has received but little attention. It could easily be worked out by any yachtsman on our coasts.

In considerable depths only one plant is known to exist. It is a lowly-organised parasitic fungus, which infests corals, boring finely-ramified canals in their hard substance. This plant was found by Prof. Martin Duncan[2] in corals dredged from over 1,000 fathoms. Fig. 3

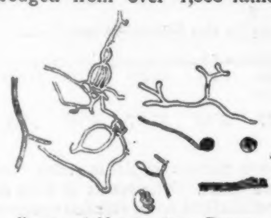

FIG. 3.—*Achlya penetrans*, Duncan.

gives a view of its appearance taken from Prof. Duncan's illustrations; you would hardly recognise it as a plant. It consists simply of a ramified mycelium and small spores. Like some other fungi which live in mines and cellars, it is able to live in the dark, because it nourishes itself upon the tissues of its hosts. It belongs to the same genus as a fungus that attacks the salmon in our rivers and kills them, and is hardly to be distinguished from that plant. It is an extremely ancient form, and infested corals even in Silurian times.[3]

Though plant life is so meagre, animal life is abundant

FIG. 4.

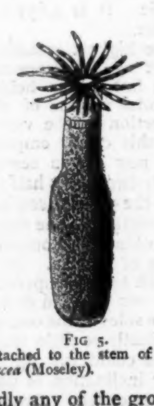

FIG 5.

FIG. 4.—*Actinia abyssicola* (Moseley). Attached to the stem of an Isis.
FIG. 5.—*Edwardsia coriacea* (Moseley).

in the deep sea. There are hardly any of the groups of invertebrate animals which inhabit our shores which are not represented in deep waters. The only ones which I know of as absent, as far as yet observed, from depths of say 1,000 fathoms and more, are Planarian worms, and certain minute animals such as Rotifers, Tardigrades, and Infusoria. It is quite possible that these minute forms

[1] *Proc. R. Soc.*, 1872, p. 587. [2] *Proc. R. Soc.*, 1876, p. 238.
[3] *Quart. Jour. Geol. Soc.*, 1876, p. 205.

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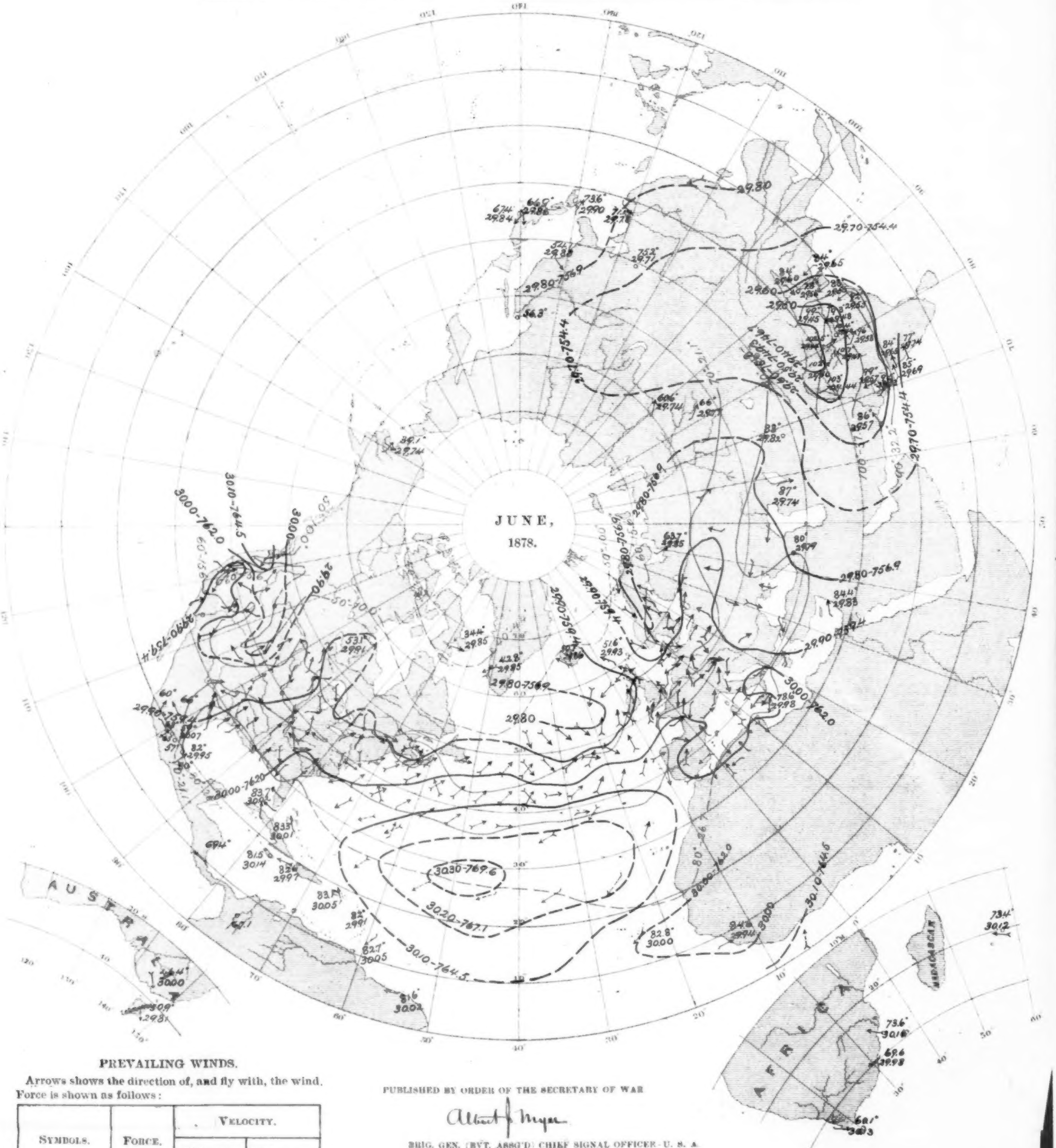
Office of the Chief Signal Officer,

UNITED STATES ARMY.

Charted from Actual Observations taken Simultaneously. Series commencing October, 1877.

No. V.



PREVAILING WINDS.

Arrows shows the direction of, and fly with, the wind. Force is shown as follows:

SYMBOLS.	FORCE.	VELOCITY.	
		Miles per hour.	Metres per second.
→	1, 2	0 to 9	0 to 4.0
→	3, 4	9.1 to 22.5	4.1 to 10.1
→	5, 6	22.6 to 40.5	10.1 to 18.1
→	7, 8	40.6 to 67.5	18.1 to 30.2
→	9, 10	67.6 up.	30.2 & over.

PUBLISHED BY ORDER OF THE SECRETARY OF WAR

Albert J. Myer

BRIG. GEN. (BVT. ASS'G'D) CHIEF SIGNAL OFFICER U. S. A.

ISOBARS AND ISOTHERMS.

Isobars in *blue*; detached barometer means in English inches.

Isotherms in *red*; detached temperature means in degrees Fahrenheit.

INTERNATIONAL MONTHLY CHART.

Showing mean pressure, mean temperature, mean force and prevailing direction of winds at 7:35 A. M., Washington mean time, for the month of June, 1878, based on the daily charts of the International Bulletin.

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may exist in great depths, but it is as well to note that we have not as yet been able to detect them, possibly from want of adequate means and of proper search.

Many genera of animals, and even some species have a vast range of depth in the sea. Some of the animals common on our sea-shores are represented in very great depths by very closely allied species. As examples may be cited two sea anemones from deep water. The close resemblance of these to forms common in our aquariums will be recognised at once.

The one, *Actinia abyssicola* (Fig. 4), from 1,350 fathoms, belongs to the same genus as the commonest anemony exposed on the rocks all round our coast at low tide. In the deep sea, in the lack of rocks for it to spread its disc out flat upon, it is obliged, as in the specimen figured, to cling round the dead stem of an Alcyonarian coral, or to clasp some similar support. The other anemony (Fig. 5) belongs to the genus Edwardsia, also found on our coasts, and nearly resembles the English species, though it comes from 600 fathoms. It has a long cylindrical body, and covers its skin with a coating of small shells gathered from the bottom mud.

A curious sea-anemony of the genus Cerianthus, may also serve as an illustration. This anemony uses its thread-cells, which other anemonies and jelly-fishes use, as bathers know, to sting with, to build itself a house. It produces the cells, which are extremely large, in great quantity, felts the threads together, and thus constructs a tube in which it lives, burying the tube in the mud, and expanding itself at the mouth ready to dart down into safety when alarmed. The tube is about 4½ inches in actual length, and is covered with small foraminiferous shells from the bottom, woven into it. A closely-allied species lives in shallow water in the Mediterranean, and I found abundance of a huge species with the tube four times as long expanding its tentacles in a depth of only a foot of water at low tide in the full glare of a tropical sun at the Philippine Islands in water which felt quite hot to my feet. Yet this deep sea form, which differs from the others in little except its size, was dredged from 2,750 fathoms, and inhabits a region absolutely devoid of sunlight, and with a temperature always close on freezing point.

The simple coral, *Bathyactis symmetrica*, of which the accompanying figure (Fig. 6) represents a large specimen, magnified to three times the natural size, ranges through all depths from 30 fathoms to 2,900 fathoms, or three miles and a quarter, almost the greatest depth from which living animals have been obtained. The coral has a world-wide range, occurring in all parts of the Atlantic and Pacific and in the Indian Ocean. It varies very much in size, some specimens being extremely minute, but I have been unable to discover any relation between the size and the different conditions under which the various specimens lived. The size does not depend on depth, temperature, or the quality of the bottom, as far as I can make out.

When I speak of a coral I shall refer only to the skeleton of the animal. The figure above represents the hard skeleton of an animal like a sea-anemony. The soft tissues have been entirely removed.

In the cases of all groups of invertebrate animals, annelids, mollusca, crustacea, we find numerous similar instances of the wide range of modern shore genera, and even species into very great depths. For example, as Mr. Davidson shows, the Brachiopod *Terebratula vitrea* ranges from 5 to 1,456 fathoms, whilst the genus Waldheimia ranges from shore to 2,160 fathoms, and Discina from 50 to 2,425 fathoms. As Mr. P. H. Carpenter has shown, the genus Antedon of our coasts ranges down to 2,900 fathoms. Amongst the Ophiuridæ, as appears from Prof. Lyman's report, the genus Amphiura ranges from 2 to 2,650 fathoms. Prof. Ehlers long ago showed that deep-sea annelids and Gephyreans belong mostly to shallow-water genera. Myriochele occurs in 2,900 fathoms, Priapulus in 2,750 fathoms, Balanoglossus in 2,500 fathoms, and Dr. McIntosh has given me similar instances, and informs me that the common shallow-water annelid, *Lumbriconereis fragilis*, ranges down to 1,780 fathoms. From Mr. Boog Watson's account of the mollusca of the *Challenger* Expedition it appears that the common shore genus Dentalium ranges down to 2,600 fathoms. Amongst crustacea Peneid and Caridid shrimps extend to all depths, whilst the barnacle Scalpellum ranges down to 2,850 fathoms.

Although many forms have this wide range, there are certain well-marked deep-sea forms which are not met with in shallow water unless in Polar regions.

The accompanying figure (Fig. 7) represents a beautiful simple coral, *Odontocyathus coronatus*, from 390 fathoms off St. Thomas, in the West Indies, immediate allies of

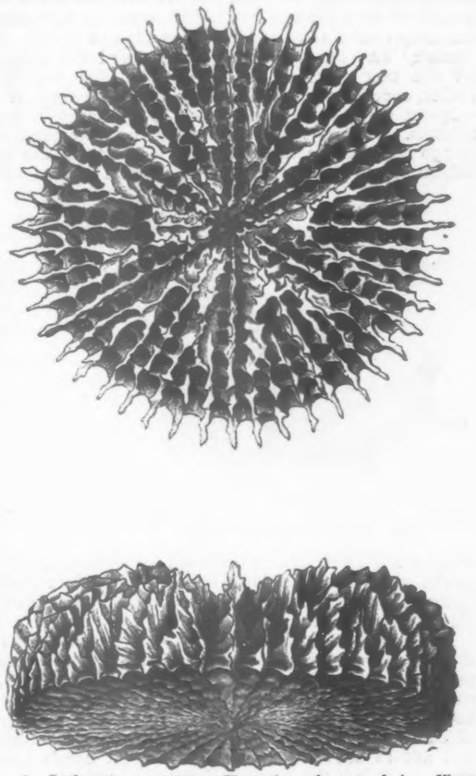

FIG. 6.—*Bathyactis symmetrica*. Three times the natural size. Viewed from above and edgewise.

which have not been found in shallow water. The coral is remarkable for having a wide flat base with tooth-like spokes all round its edge, no doubt a contrivance for keeping it upright as it rests on the mud at the sea bottom. The genus of corals, Stephanotrochus, may also be cited as confined at present, as far as known, to deep water. Four species of the genus were dredged by the *Challenger* in from 410 to 1,000 fathoms. All but one of them, which was obtained off New South Wales, were dredged in the Atlantic. The species here figured (Fig. 8) *Stephanotrochus diadema* was from 1,000 fathoms off the Azores.

There being scarcely any difference in the conditions of life from a depth of 500 fathoms downwards, the deep-sea fauna exhibits no zones of distribution in depth. Its upward limit rises in some parts of the world higher towards the coast line, in others lies lower, according to the varying conditions of light temperature-currents and

food. In the higher latitudes it approaches shallow water. In the Straits of Magellan we dredged blind crustacea and other elements of the deep-sea fauna in 120 fathoms; but even in the tropics the deep-sea fauna is met with at comparatively small depths. Off St. Thomas in the Danish West Indies, for example, deep-sea animals are extremely abundant at 450 fathoms.

From the upper limit of range the deep-sea fauna, speaking generally, extends downwards continuously, without break or defined limit of range of species or genera. We had not in the *Challenger* time to make series of dredgings to determine the upper limit of the deep-sea fauna. It may lie in the places cited much nearer to the surface than stated. At Cebu, in the Philippines, far within the tropics, vitreous sponges occur in abundance at 95 fathoms, and the deep-sea fauna may almost be said there to reach that upper limit, although the temperature at that depth is as high as 70° F. Mr. Agassiz,[1] who has so thoroughly explored the deep-sea off the east coast of North America and the West Indies, concludes in his latest report that the range of the deep-sea fauna should be carried as high as 300 or 350 fathoms. He terms the fauna extending from the shore to 150 fathoms the littoral fauna, whilst from the 100-fathom line to the 400-fathom line extend species which are neither littoral nor have the wide geographical distribution belonging to forms found below that depth. We might term the inhabitants of this interval the intermediate fauna. Dr. Günther tells me that he has arrived at similar conclusions from his examination of the deep-sea fish collected by the *Challenger* expedition. Below 350 fathoms no zones of depth are to be made out in their distribution.

The geological bearings of these facts are all-important. We shall never be able to tell from the fossil contents of strata whether they were deposited at 400 or 2,500 fathoms. Even more, since some species and very many genera range at present from the shore to vast depths, many forms now restricted to deep water may formerly have lived in less depths, and most probably did so. Moreover as the present deep-sea fauna varies so much in upward range in different places and climates, so also probably did it vary in geological times. We can therefore not even form conclusions of any value from these grounds as to the depths at which a deposit was formed, from 400 fathoms upwards, until the region of reef-coral and plant-life is reached. We must rely on other evidence.

The question would not be one of much importance if, as Prof. Geikie concludes, all the geological deposits with which we have to deal are shown, by containing ripple-marks and otherwise, to have been formed in shallow water,[2] but many geologists are, I believe, opposed to his views in this matter.

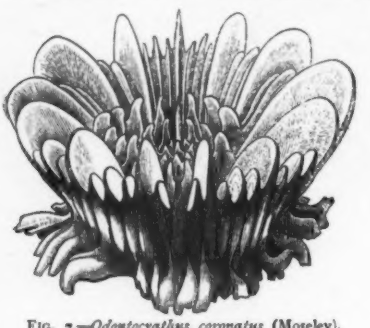

FIG. 7.—*Odontocyathus coronatus* (Moseley). Magnified to twice the natural size.

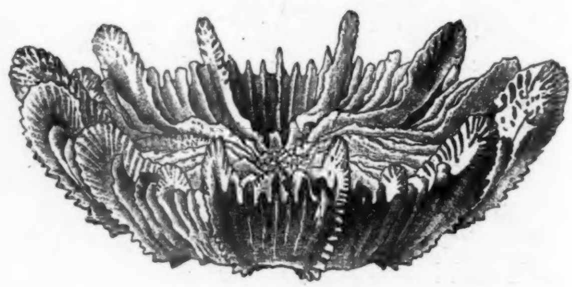

FIG. 8.—*Stephanotrochus diadema* (Moseley). Once and a half the natural size.

A most important feature of the deep-sea fauna is that it is world-wide in its distribution. I have already referred to a species of coral, *Bathyactis symmetrica*, which ranges all over the world. Fig. 9 represents another coral, *Cryptohelia pudica*, which is a hydroid allied to the jelly-fishes which float on the sea-surface, and not to sea-anemonies like the other corals I have shown. This is the common skeleton of a highly complex colony. Each of the small swellings on the branches contains a group of animals. In the centre of each group is lodged an animal with a mouth and stomach, and all round were others without mouths. The latter catch the food and give it to the central animal, which digests it and nourishes them and the whole coral tree by means of a complex system of canals. Other animals perform solely the function of rearing the young. The fully-developed larvæ are worm-like, and when ready escape and swim away to found each a new colony. For corals, like us, travel in their youth and see the world, and become stationary like us only in later life. Each group of animals is covered by a protective lid, hence the name of the coral, Cryptohelia. It occurs all over the world in from 350 to 1,500 fathoms.

Some few deep-sea forms appear to have a restricted range. I say appear, because we have dredged some few as yet only from one locality, but so little deep-sea dredging has been done that probably these will be found elsewhere in the future.

No better instance of the world-wide range of deep-sea forms can be cited than the fact that Portuguese fishermen fishing for deep-sea sharks in 450 fathoms off the coast of Portugal bring up the Glass-rope Sponge entangled on their lines, and that Japanese fishermen fishing off Inosima in more than 300 fathoms catch sometimes a shark of the same genus as that caught by the Portuguese, and bring up at the same time an almost identical sponge. The sponge reached England first from Japan.

There is absolutely nothing to restrict the geographical range of animals in the deep sea. Dr. Wallich, the pioneer of deep-sea research, eighteen years ago recognised the deep homothermal sea "As the great highway for animal migration, extending from pole to pole." Below 500 fathoms it is everywhere dark and cold, and there are no ridges that rise on the ocean bottom to within 500 fathoms of the surface, so as to bar the migration of animals in the course of generations from one ocean to another, or all over the bottom of any one of the oceans. The apparently shallow barriers seen in the map of Atlantic and Pacific have over 1,000 fathoms of water upon them.

Were there any variations in the conditions of life such as to restrict certain animals to very great depths, as mountain plants are restricted to certain heights on land, then we might expect to find a peculiar fauna in the deep

[1] *Bull.* Mus. Comp. Zool., vol. v. No. 14, p. 294.
[2] *Proc.* R. Geog. Soc., 1879, p. 426.

depressions, and especially in the deepest hollows on the bottom of the sea, where the water is over 4,000 fathoms deep; but such is not the case as far as we know. The deepest depressions lie in the North Pacific, the deepest of all being one close to the Kurile Islands, the soundings there being 4,655 fathoms.

Mr. Alexander Agassiz has glanced over and helped to sort the whole deep-sea collection made by the *Challenger*, and he believes that the collection made by the successive dredgings of the United States Government in deep water off the eastern coast of the United States and the West Indies contains almost all the types dredged by us all over the world. No better proof of the ubiquity of deep-sea species could be given. We got quite tired on the *Challenger* of dredging up the same monotonous animals wherever we went.

Many animals which occur in deep water in temperate and tropical regions occur in shallow water in high latitudes. Hence it is usually concluded that an Arctic or Antarctic fauna has colonised the deep sea; but probably it is also

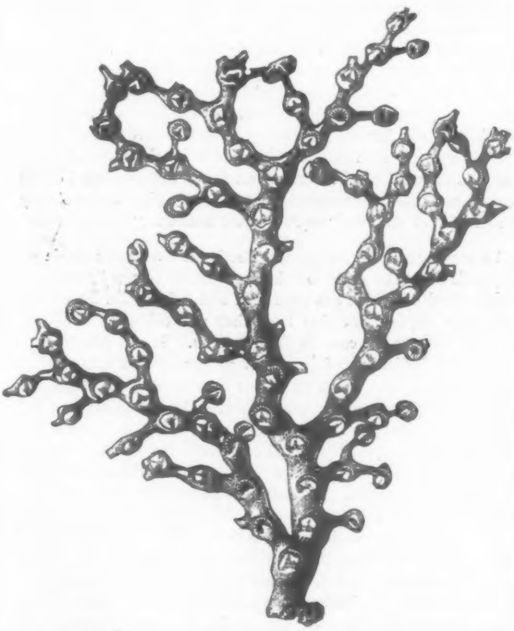

FIG. 9.—*Cryptohelia pudica* (M.Edw. & H.). Twice the natural size.

the case that deep-sea forms have moved up into shallow water in polar regions, because there the temperature is low and the water is dark during most of the year, both from the absence of sun or the obliquity of its rays, and because of the covering of the water by ice and snow. Probably colonisation has taken place in both directions. Some of the identical animal forms occurring at New Zealand and Great Britain may have moved up from deep water at both places.

The higher we rise into shallow water above the limit of the deep-sea fauna, the more restricted becomes the geographical range of the species occurring. I may cite an instance. Off the Aru Islands in the Malay Archipelago we dredged in 129 fathoms at the same haul a number of corals and other animals, nearly all of which we did not find elsewhere, and which I believe Mr. Agassiz has not found off the American coast.

(*To be continued.*)

NOTES

WE are sure our readers of all shades of politics must regret that Sir John Lubbock has lost his seat in Parliament. We have nothing to do with the immediate causes of his defeat, but for the sake of science and enlightened legislation we trust he may find some other constituency liberal enough in the best sense of the term, to choose him as its representative. Meantime his loss is to some extent made up for by the election of Prof. Maskelyne, though we trust the latter's duties as a legislator will not lead to the neglect of what we consider his much higher function of original research.

WE have some further details concerning the new agricultural college about to be opened near Salisbury. Mr. John Wrightson, for many years Professor at Cirencester, and well known for his contributions to scientific agriculture, is converting his house and extensive farm near Downton into an institution which shall combine lands worked by himself with a teaching staff mainly composed of experienced professors once at the Royal Agricultural College. There is plenty of room, not for one new college only, but for half a dozen; and the present scheme commends itself to us in many ways. We feel sure that it will work in friendly rivalry with Cirencester, avoiding its mistakes while profiting by its experience. We would suggest that some shorter title than the "South Wiltshire and Hampshire Agricultural College" should be found for the new institution.

WE understand that Prof. Boyd Dawkins, F.R.S., of Owens College, Manchester, has accepted an invitation to give a course of lectures at the Lowell Institute, Boston, Mass., in October and November of this year.

THE eighteenth meeting of the delegates of the French Sociétés Savantes took place at the Sorbonne on March 31. M. Regnier, President of the Archeological Section, was the president at the inaugural sitting. He was assisted by M. Milne-Edwards, President of the Science Section, and M. Delisle, President of the Historical Section. In his speech the President spoke in some detail of the heliographical reproduction of old manuscripts published recently in England. The Section of Science was divided as usual into three commissions. M. Allegret, Professor of the Faculty of Lyons, was appointed President of the Commission for Mathematics; M. Filhol, Professor to the Faculté des Sciences of Toulouse, President of the Commission for Physico-Chemical Science; and M. Cotteau President of the Commission of Natural Sciences. The General Sitting of Sciences were presided over by M. Milne-Edwards, assisted by M. Faye and M. Wurtz. The distribution of prizes took place on Saturday, April 3, under the presidency of M. Ferry, the Minister of Public Instruction. Prince Oscar of Sweden, Prof. Nordenskjöld, and Capt. Palander were present, and greatly cheered by undergraduates and spectators. Except the allusion to the high rewards, the speech of M. Ferry was almost entirely confined to educational topics. According to the proposals of the Commission of Sciences gold medals have been awarded to Dr. Crevaux for his explorations in Tropical America, M. Crova, Professor to the Faculté des Sciences de Montpelier, and M. Violle, Professor to the Faculté of Lyons, for their works in Physics; M. Pierre, as Director of the Botanical Garden of Saigon (Cochin-China), and MM. Chantre and Falsan for their studies of the old glaciers of the Rhone.

THE Italian Minister of Agriculture and Commerce has decided to present to Parliament a project for executing a great geological map of the kingdom. The expense is calculated at 6,000,000 francs.

SHOCKS of earthquake were felt at Tenez, on the Algerian coast, on March 2, at 8.30 p.m., and at Orleansville and Tenez on the 25th, at 5.20 a.m.

THE *Gardeners' Chronicle* regrets to hear of the decease from cholera of Adolf Biermann, the Curator of the Royal Botanic Garden, Calcutta.

ON the 1st inst. the Geological Society of France celebrated the fiftieth anniversary of its foundation.

THE annual meeting of the Paris Physical Society took place on April 2 in the large hall of the Société d'Encouragement. It was very well attended, the hall having been lit by ten Werdermann lights, which worked with great regularity and gave a very pure illumination. Very few new experiments were made. We must notice, however, a new use of M. Trouve's polyscope. M. Trouve placed his electrical polyscope in the stomach of a fish swimming in an aquarium, and without its seeming to suffer any inconvenience, it radiated a light equal to one common candle.

IN various works on botany M. Alph. de Candolle has remarked (*Arch. des Sciences*, March), there are enigmatical and even unintelligible descriptions, which it would have been better not to publish. And this is the case not only with incompetent writers, but with those of the first rank. He gives a list of *species dubiæ*, &c., from vols. xiv. to xvii. of the *Prodromus* (published 1856–1873), referred to their authors (deceased), care having been taken to attribute each enigma to its true origin. Those volumes of the *Prodromus* contain 11,056 species classed and described, and the enigmatical amount to 562, or about 5 per cent. It is noted that there are pretty large proportions of enigmas (1) in certain authors who have written much, as Blume (66), Miquel (59), Roxburgh (20), Kunth (19), Sprengel (17); (2) in authors who have published only one or two volumes, or even simple memoirs, such as Blanco (32), Opiz (28), Loureiro (15), Don (14), Noronha (11), Griffith (11), Hamilton (11) . . . Martens and Galeotti (4). (The extent of the writings must be taken into account.) Three great naturalists who have written much, viz., Linnæus, Lamarck, and Brown, stand together about the middle of the list, with the numbers 7, 9, and 8 severally. M. de Candolle refers further to a document by Endlicher, in which that naturalist gives a list of enigmatical genera, amounting to 109 out of the 6,895 genera known in 1840, or about 1½ per cent. Analysis here shows that the incapable or mediocre authors have given most enigmas. Père Vellozo (29) is most prominent in this respect, and a regret is expressed that he, with some other culpable *pères* (Blanco, Loureiro, &c.), did not confine themselves to writing homilies. The troublesome result of certain publications has now rendered botanists more prudent.

THE Belgian Academy of Sciences has announced the following subjects of prize competition for 1881:—In mathematical and physical sciences: 1. Extend, as much as possible, the theories of points and straight lines of Steiner, Kirkman, Cayley, Salmon, Hesse, Bauer, to properties which are, for superior plain curves, for surfaces and for twisted curves, the analogues of the theorems of Pascal and Brianchon. 2. Extend to eight points of a curve of the third order the anharmonic property of four points of a conic. 3. New researches on the spectrum of oxides, chlorides, and bromides of barium, calcium, and strontium, whose absolute purity has first been proved by chemical analysis. In natural sciences: 1. New researches on the germination of seeds, especially on the assimilation of nutritive deposits by the embryo. 2. New researches on development of Trematoda, from the histogenic and organogenic point of view. 3. New stratigraphical, lithological, and palæontological researches fitted to determine the arrangement or order of succession of layers of the formation named Ardennais by Dumont, and at present considered as Cambrian. The value of the medals awarded will be 600 francs for each question. Memoirs (which may be in French, Flemish, or Latin) are to be sent in, with mottoes as usual, before August 1, 1881. (A prize question on torsion is reserved for the programme of 1882.)

FROM the following extract from the *Planter's Journal*, quoted in the *Barbados Globe* of March 8, it will be seen that science has reached that remote colony:—"Those who are interested in the agricultural prosperity of Barbados will have observed with pleasure the increased attention that has of late been paid here to the application of the methods and improvements of scientific agriculture to the raising and reaping of our staple crop. The planter is more and more fully realising the fact that, if he is to hold his own in the face of the competition that is springing up all around him in the field where his supremacy was once unquestioned, he must persistently and patiently invoke the aid of the processes and the discoveries which science offers to those who seek her. Hence it is that we have now, under the provisions of the Education Act, 1878, an Island Professor of Chemistry and Agricultural Science; that there is besides a private analytical chemist resident amongst us; and that the Barbados Agricultural Society has appointed a Chemical Committee, which has for some months been steadily engaged in doing good, though unostentatious, work in obtaining analyses of manures and similar matters. The result of these movements is seen in the encouraging fact that the prudent planter, in purchasing his foreign fertilisers, is more careful in inquiring into their quality, and, as a necessary consequence, the agents for the better class of manures are willing to meet his requirements by placing before him satisfactory analyses of the articles which they offer for sale. There prevails therefore in the manure market a better condition of things both for the buyer and for the honest vendor—the former receiving more value for his money, and the latter running less risk of being undersold by the fraudulent maker of 'sophisticated' manures."

IN consequence of the general election it has been considered advisable to fix the date for the Conference on the Progress of Public Health—which has been held annually by the Society of Arts since 1876—somewhat later than was originally intended, or than has been the case in former years. It will therefore be held in the beginning of June. A programme of subjects for discussion has been drawn up by the Executive Committee, and will be submitted to the Conference. The following are the subjects included:—1. The development of Local Government administration, especially by the constitution of County Boards. 2. The extension of the powers of the local authorities of urban and rural sanitary districts. Amendments in the Public Health Act. 3. Sanitary inspection and classification of dwellings. 4. Amendments in the Rivers Pollution Prevention Act. 5. The advisability of strengthening the administrative organisation of the Local Government Board. Local Government Board Administration Areas. 6. Further suggestions by sanitary authorities. The programme will also be issued to sanitary authorities throughout the kingdom. It is not proposed to make any attempt to procure papers which may be read and discussed; but the Committee state that they will be glad to receive any communications containing fresh information or giving accounts of progress made since the last Conference. Such communications, if approved by the Committee, will be printed and circulated at the Conference, but it is probable that time will not admit of any discussion being taken upon them.

THE Scientific Committee of the Royal Horticultural Society, having appointed a committee to collect evidence and report the effect of the past severe winters and cold summer on trees, shrubs, and plants, will be glad of the co-operation of all horticulturists interested in the subject, whether members of the Society or not. Forms are in preparation for filling up, and may be had on application to the Secretary, South Kensington.

WE regret to hear that the University of St. Andrew's is in such difficulties that it has been resolved to reduce the salaries of the professors to a considerable extent for some years, unless her

old alumni and other friends come to the rescue. A large part of the income of the University is derived from the farms which form part of its endowment, and the recent depreciation of this kind of property has seriously affected the moderate income of the University, which we hope will be able to weather the storm.

THE University of Buda-Pesth, which was founded in 1635, intends to celebrate, on May 13, the hundredth year since its revival and development by Maria Theresa. There will be a thanksgiving service in the morning and a grand academical and civic procession through the streets. An oration will be delivered and an ode recited, and there will be a banquet, to be followed by a grand ball. In honour of the occasion medals will be struck, honorary degrees will be conferred on distinguished men, and a work by the Hungarian Minister of Justice, Pauler, describing the work of the University during the last 100 years, will be published.

IN consequence of the unavoidable absence of Dr. C. W. Siemens, his paper at the Society of Telegraph Engineers, on "The Application of the Dynamoelectric Current to the Fusion of Defractory Materials in considerable Quantities," which was to have been read on the 14th inst., is postponed until the 28th inst. The papers to be read will be seen from our Diary.

BAUMGARTNER, the inventor of a navigable balloon, having three cars attached, each with ten or twelve wings, set in motion by a crank, has attempted an ascent at Leipzic. On the rope being cut the balloon rose very slowly, skimming the house-tops, whereupon the two assistants jumped out of the centre car in alarm. The balloon shot up to a great height, then burst and fell. Baumgartner was not seriously hurt, and is resolved on a second experiment.

THE ship *Border Chief*, which arrived at Melbourne from London on February 14, reports seeing an iceberg of very large proportions in lat. 47° S. and long. 52° E. This ice island was considered to be about 250 feet high and about five miles in length. Another vessel, it is stated, struck an iceberg on March 26, in lat. 46° N., long. 48° W., and sank next day. A Cardiff steamer on her homeward voyage from New York encountered an immense mass of drift-ice, which it took forty-eight hours to get clear of; in steaming through it she received several injuries. No fewer than 100 icebergs are stated to have been seen on the passage.

THE season is extremely rainy in Algeria, and an almost unexampled occurrence has taken place; inundations have destroyed some houses at Nemours, and the traffic on the railway from Arzew to Saïda has been obstructed by the fall of rocks undermined by the recent rains. A magnificent crop is anticipated, and travelling in the Sahara will be exceptionally easy this summer.

WE have on our table the following works:—"The Field Naturalist's Handbook," Rev. J. G. Wood and Theodore Wood (Cassell); "Water Analysis," E. Frankland (van Voorst); "Botany for Children," Rev. G. Henslow (Stanford); "Ethnology," J. H. Painter (Baillière); "Guide to the Electric Testing of Telegraph Cables," V. Hoskier (Spon); "The Influence of Colloid upon Crystalline Form and Cohesion," Dr. W. M. Ord (Stanford); "Introduction to the Science of Language," 2 vols., A. H. Sayce (Kegan Paul); "Indian Notes," F. K. Hogg, M.D. (Churchill); Publications of the Cincinnati Observatory; "Micrometrical Measurements of Double Stars;" "The Constitution of the Earth," R. Ward (G. Bell and Sons); "The Disestablishment of the Sun," John Bland (Sprague and Co.); "Abbildungen von Vogel-skeleten," Dr. A. B. Meyer (Dresden); "A Criticism of Dr. Croll's Molecular Theory of Glacier Motion," J. J. Harris Teall (Simpkins); "Secret of a Good Memory," J. Mortimer Granville (Bogue); Journal of the Royal Society of New South Wales, and Annual Report of the Department of Mines of New South Wales (Trübner); "Notes of Observation of Injurious Insects;" "Astronomie Populaire," Camille Flammarion; "Practical Chemistry," W. A. Tilden (Longmans); "The Sidereal Messenger of Galileo Galilei," E. S. Carlos (Rivington); "British Marine Polyzoa," 2 vols., Thomas Hincks (van Voorst); "United States Geological Survey," vol. xii. 1879; "Testing Instructions," vol. ii., Schwendler (Trübner); "Physiology of Religion," part 1, Henry Lee (Trübner); "Transactions of the Cremation Society of England" (Smith, Elder); "International Dictionary for Naturalists and Sportsmen," E. Simpson Baikie (Trübner); "The Geological Record for 1877," edited by W. Whitaker (Taylor and Francis); "Henry's Contribution to the Electro-Magnetic Telegraph," W. B. Taylor (Washington); "Die Beobachtung der Sterne, Sonst und Jetzt," J. Norman Lockyer (Vieweg und Sohn); "Japanese Metric and English Weights and Measures," Edward Kinch (Tokio); "Annuaire de l'Académie Royale des Sciences;" "Elements of Modern Chemistry," Adolphe Wurtz (Swan, Sonnenschein, and Allen); "Geography," Keith-Johnston (Stanford); "Philosophie Scientifique," H. Girard (Trübner); "Australian Orchids," part 5, R. D. Fitzgerald (Trübner).

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. G. Kirby; a Prince Albert's Curassow (*Crax alberti*) from Columbia, presented by Mr. H. B. Whitmarsh; a West African Love Bird (*Agapornis pullaria*) from West Africa, presented by Mr. J. W. Gillespie; a Long-eared Owl (*Asio otus*), captured in the Red Sea, presented by Dr. Wm. Anderson; a Greater Black-backed Gull (*Larus marinus*), European, presented by Mr. E. Thornhill; a Slow-worm (*Anguis fragilis*), British, presented by Mr. Leslie Jeyes; two Dingo Dogs (*Canis dingo*), two Red Kangaroos (*Macropus rufus*), two Vulpine Phalangers (*Phalangista vulpina*, var.), two Mauge's Dasyures (*Dasyurus maugæi*), a Short-headed Phalanger (*Belideus breviceps*), two Emus (*Dromæus novæ-hollandiæ*) from Australia, two Common Wombats (*Phascolomys wombat*), from Tasmania, a Weeper Capuchin (*Cebus capucinus*) from Brazil, a Horned Tragopan (*Ceriornis satyra*) from the South-east Himalayas, deposited; a Feline Dourocouli (*Nyctipithecus vociferans*) from South Brazil, a Rock Cavy (*Cerodon rupestris*), a White-spotted Rail (*Rallus maculatus*), an Orinoco Goose (*Chenalopex jubata*), a Brazilian Teal (*Querquedula brasiliensis*) from Brazil, purchased.

GEOGRAPHICAL NOTES

As might have been expected, Prof. Nordenskjöld and his companions have met with an enthusiastic reception in Paris, both from Government, from the scientific societies, and from the general public. Delegates from the Government received him on his arrival, the unusual honour of a Commandership of the Legion of Honour has been conferred upon him, while Capt. Palander has been made an officer. He was present at the public meeting of the Sociétés Savantes, when he received a warm reception, while the Geographical Society received him publicly in the Cirque of the Champs Elysées. On Sunday a banquet at the Hôtel Continental was given him, with Prince Oscar of Sweden as president, and on Monday another banquet by the Geographical Society as a body, while the municipality of Paris presented him with a special gold medal. We wonder if any member of the municipality of London could tell who Nordenskjöld is, or what he has done, that all Europe, except England, should make so much fuss about him. Such a reception as he has had in Paris in its nationality and publicity contrasts markedly with the treatment he received here. No doubt he arrived at an unfortunate time, but

surely, if the transition state of the Government excused inaction on its part, the Geographical Society could have organised a meeting, even although a prince was not at hand to take the chair. Possibly after all our insular want of sympathy with foreign enterprise, however great, may account for the absence of that enthusiasm which greeted our own abortive expedition of three years ago. The English edition of Prof. Nordenskjöld's narrative will be published by Macmillan and Co.; it will appear simultaneously in English, Swedish, German, and French.

M. J. PALMARTS has published at Brussels a pamphlet entitled "Projet d'Exploration au Pole Nord," in which, after a preliminary disquisition of a general nature, he expounds his plan for the construction of a submarine apparatus to attain the object in view. The *Times* Naples correspondent states that the *Cristoforo Colombo* is now in course of preparation for an exploring voyage in the North Seas.

THE current number of the Geographical Society's *Proceedings* contains Mr. J. Thomson's report of his journey from the head of Lake Nyassa to the south end of Lake Tanganyika, followed by Maj.-Gen. Sir M. A. S. Biddulph's paper on Pishin, and the routes between India and Candahar, which furnishes a vast amount of new topographical information. In order to make this more readily intelligible, it is illustrated by some excellent wood-engravings from, we believe, the author's own sketches, and a good map of part of southern Afghanistan, constructed from surveys made during the late expedition, on which the unexplored country to the east is usefully indicated. A proposal is made by Admiral Ryder to found medals for the encouragement of surveying by naval officers, which the council of the Society, after careful consideration, think had better be placed in other hands. Among the remaining matter is Dr. Holub's address on the subject of the Marutse-Mabunda empire, but the publication of the map to illustrate his former paper appears to be unavoidably postponed.

IT is stated that a new Belgian expedition is to leave this month for the purpose of establishing commercial stations along the Congo.

M. SLATIN, an Austrian traveller, is about to visit Dara, in Darfur, and proposes to explore the country to the south of Hofrat-el-Nahas and Kalaka. MM. de Müller-Capitany and de Lucken have recently left Cairo for Massowah, whence they intend to visit the region bordering on Northern Abyssinia. After spending a year there they will direct their course to Fazokl, by way of Valkait and Gallabat, and they will then endeavour to penetrate southwards into the Galla country.

MM. POPELIN AND CARTER, with the second Belgian Expedition, have arrived at Karema, M. Cambier's station on Lake Tanganyika, but it is said that only one elephant has survived the journey. Under the auspices of the King of the Belgians an establishment is to be formed in Eastern Africa for the capture and training of elephants. A further Belgian expedition is to be despatched to Karema under Capt. Ræmaekers and his brother, who will take with them three artisans and also a small steamer for use on Lake Tanganyika.

THE French Committee of the International African Association have despatched M. Bloyet to Zanzibar to undertake the formation of their station in Usagara.

COL. GORDON-PASHA has recently informed the Church Missionary Society that the Egyptian military station on the Uganda frontier had been moved back, and that consequently the country between Egypt and Mtesa's kingdom is in an unsettled and insecure state, being overrun by Kaba Rega's men. The road to the Victoria Nyanza by way of the Nile is therefore not now practicable. The two members of the Nyanza Expedition, the Rev. C. T. Wilson and Mr. Felkin, with three Waganda chiefs, are expected to arrive in England during the present month, as they had reached Suakim on March 16. Mr. Wilson will thus be the first Englishman, since Speke and Grant, who has traversed Africa from Zanzibar to Uganda, and thence down the Nile.

HERR CARL LAMP gives some striking illustrations in *Globus* of the hatred that exists between the Mayos of Yucatan and the Mexican Creoles. He shows how important the exploration of the country would be, but the explorer must take his life in his hand. The same number (13) of *Globus* contains some interesting details of Mr. C. M. Doughty's journeys in North Arabia.

THE leading contribution to the new number of the *Annales de l'Extrême Orient* is Count Meyners d'Estrey's paper on Sumatra, being a communication recently made by him to the Société Académique Indo-Chinoise.

THE new part of *Le Globe* contains a suggestive paper on the *rôle* of missionaries, looked at from a geographical standpoint.

ON the 16th inst. Prof. Vambéry is to read a paper at the Society of Arts on "Russia's Influence over the Inhabitants of Central Asia during the last ten years." Prof. Vambéry's intimate knowledge of Central Asia lends great value to anything he may say, though it is well known his opinions are rather violently anti-Russian. He is coming to London expressly to read the paper, and is expected here on the 13th. Sir Douglas Forsyth is announced to preside at the meeting.

ACCORDING to an evening contemporary the Moscow correspondent of the *Kölnische Zeitung* writes that a war between Russia and China may result in the occupation of Tchikislar, and that the fanatical Mahommedan population of Tchikislar is the surest ally for Russia! At first sight this was rather confusing, but the further statement that Russia "has a pretender for Tchikislar *in petto*—an elder son of Yakoob Khan," inclines us to the belief that the writer may not impossibly be confounding Kashgar with Tchikislar!

THE HISTORY OF MUSICAL PITCH[1]

"PITCH" is itself merely a sensation due to, and hence measured by, the number of double or complete vibrations, backwards and forwards, made in one second of time by a particle of air while the sound is heard. It is convenient to call the pitch of a musical sound the number of vibrations to which it is due. "Musical pitch" is the pitch of the "tuning note," or that by which all other notes on an instrument with fixed tones is regulated according to some system of tuning or "temperament." Of these, two are of prominent importance in the history of pitch, the "Mean-tone" and the "Equal," the first being also frequently called "unequal." In mean-tone temperament, completed by Salinas in 1577, all harpsichords and pianos were originally tuned in England till 1844, and all organs till 1854. It may still be heard on Green's organs at St. George's Chapel, Windsor, Kew Parish Church, and St. Katharine's, Regent's Park, and on a few country organs. It consists in flattening the Fifths of the scale sufficiently to make the major Thirds perfect, so as to sound without beats. As long as the player did not employ more than two flats or three sharps this answered very well indeed. But on introducing a third flat or fourth sharp he had to play them by substitution, and hideous noises, called "the wolf," were produced, and hence players have agreed to accept the much less perfect equal temperament, in which the Fifths are scarcely perceptibly flattened, (and the major Thirds are made very much too sharp (producing the unpleasant "grittiness" of the harmonium), because at any rate all the keys are alike and the wolves are reduced to cubs.

It is convenient to consider A as the tuning note in all cases, but pianos and organs are usually tuned to C. The following relations give an easy sum in the rule of three for passing from A to C, and conversely. In equal temperament A 444, that is, the note A making 444 double vibrations in a second, corresponds to C 528, and conversely. In mean-tone temperament A 418 corresponds to C 500, and conversely, whereas for a perfect minor Third between A and C, A 440 corresponds to C 528, and conversely.

Man's memory of pitch is generally weak and short, though there are a few exceptions. Even in running down an octave unaccompanied singers will often flatten pitch. Hence some means of handing down pitch is necessary. The only carriers of pitch which need be noticed are the organ-pipe and the tuning-fork, which dates from 1711, so that for all older pitches the organ-pipe is the sole, as it still is the principal, authority. Both pipe and fork alter with temperature. The pipe alters, roughly speaking, by one vibration in every thousand for each degree Fahrenheit, sharpening by heat and flattening by cold. This is an extremely important change, and all pitches of organs must be reduced to one standard temperature, for which 59° F. =

[1] Re-arranged and abridged by the Author from a paper on the same subject read before the Society of Arts on March 3, 1880, by Alexander J. Ellis, F.R.S., F.S.A. For a detailed authentication of the facts herein mentioned reference must be made to the *Journal* of the Society of Arts for March 5 and April 2, 1880.

15° C. = 12° R. is here selected and used. The tuning-fork alters only by 1 vib. in 21,000 for each degree Fahrenheit, flattening by heat and sharpening by cold (the exact contrary to an organ-pipe), but this minute change may generally be disregarded. It is best, however, to reduce forks also to the same standard temperature. The tuning-fork, if carefully treated, will probably retain its pitch exactly for any number of years, since we know by examination that some forks have not varied one-tenth of a vibration from 1837 to 1880. Even very bad rusting does not flatten a fork by more than 4 vib. in 1,000.

Suppose then that we had a series of forks, tuned in unison with the different A's of different organs and other instruments, how are we to appreciate the difference between them, independently of the ear, which, even when well trained, is found to be most unsatisfactory in the judgments it forms as to the magnitude of an interval? The only satisfactory method is to measure them, that is, to determine the number of vibrations in each fork. For this purpose there are elaborate contrivances, but only one is easy of application, and, as has been ascertained by experiment, the results I have obtained by it do not differ by so much as one-tenth of a vibration from those yielded by the beautiful machines of Prof. McLeod and Prof. Alfred Mayer, who kindly tested my determinations by them. The "tuning-fork tonometer" was invented by J. H. Scheibler (1777-1837), silk manufacturer of Crefeld. Its principle is this: Two tuning-forks of nearly the same pitch, when sounded together, break up their continuous tones into a succession of loudnesses and weaknesses, called beats. The number of such beats that take place in ten seconds can be easily counted when it lies between ten and fifty, and most easily when it is forty. The number of beats in one second is exactly equal to the difference of the pitches of the two forks. Then again each fork can be made to produce its own octave by being held over a proper resonance-jar, and this octave will beat with another fork nearly of its own pitch. Then from any selected low fork, say about A 220, a series of sharper forks, each beating (roughly) four times in a second with the preceding, is constructed, until one is reached which beats with the octave of the lower fork. Then all the forks are allowed several weeks to cool and settle, and the beats are afterwards counted with perfect accuracy, a very long, tedious, and extremely difficult operation. The sum of all the beats between the lowest fork and its octave is the pitch of the lowest fork, whence that of all the intermediate forks is immediately known. This done, the determination of the pitch of any fork or pipe, whose note lies within the octave counted, is very easy. The forks I used belonged to Scheibler himself, and were kindly lent me by Herr Amels, but I had to do the counting myself, and Professors McLeod and Mayer kindly enabled me to verify the results. It was by means of these forks and others tuned from them that I was able to measure the pitches of other forks and of pipes, and thus obtain the materials for this history.

First a large number of forks were obtained, most kindly lent or copied for me by numerous helpers; then I determined the pitch of a large number of organs, or obtained forks tuned to them at known temperatures. Organ-builders helped me with ancient pipes they had preserved from old organs. Pipes, of which the dimensions were given in old books, were reconstructed full size or to a scale, and their pitches measured. Then the records of other investigators of pitch were searched, and their procedure ascertained. The chief of these were the measures made by Scheibler; by Näke with Scheibler's forks; by Delezenne with a sonometer tuned to a fork of Marloye's, the accuracy of which I tested; by Lissajous, probably with the siren and bellows of constant pressure; by Cagnard de la Tour with the siren; and the older determinations of Dr. Robert Smith (master of Trinity College, Cambridge), Fischer (of Berlin), Euler, and Marpurg made with a weighted string. From these, together with my own, I collected more than 320 pitches, nearly half of which were for the first time measured by myself, reaching from A.D. 1361 to the present day, and on these the following history is based.

Early musical pitch was of two kinds, known as the *Church pitch* (*Chor-Ton, Ton de Chapelle*) and the *Chamber Pitch* (*Cammer-Ton, Ton de Chambre*), the former adapted to the ecclesiastical tones, the latter to the freer secular music performed in the private apartments or "chamber" of the prince, for his own pleasure, as the band used both in church and chamber consisted generally of his paid servants. Chamber pitch was also generally used for private, secular, and convivial music of all kinds. The confusion in most books between these two pitches is exceedingly great, and the confusion has been increased by Prætorius, 1619, who insists upon calling the higher pitch the chamber pitch, whether it was used in church or chamber, and who introduces a new pitch, which he considers suitable to church (*chormässig*).

That the general reader should be able from the first to form some practical notion of differences of pitch, it may be mentioned that "mean pitch," as it will be called, or Handel's and Prætorius's suitable pitch, is still used in the three churches I have described as using mean-tone temperament, and with equal temperament at All Hallows the Great and Less, Upper Thames Street, at the German Chapel Royal, St. James's Palace, and in many country organs, as Wimbledon, St. George's Chapel at Great Yarmouth, St. Nicholas at Newcastle-on-Tyne. The "French pitch," about a quarter of a tone higher, may be heard at Fulham parish church, in many country churches, as Arundel, Barking, St. Mary's, Shrewsbury, and will be probably heard at the Covent Garden Opera this season. An ancient "medium pitch," about the tenth of a tone sharper than the French, now adopted as a church organ pitch by all the principal organ-builders, unless some other pitch is specially ordered, may be heard on a genuine old organ at Hampton Court Palace, and on the present modern alterations of the old organs at Westminster Abbey, St. Paul's Cathedral, the Temple Church, Whitehall and St. James's Chapels Royal, and many other organs. It is practically what the Society of Arts pitch was intended to be. The modern high "orchestral pitch" used at present in England, which is also the *highest* pitch used by Broadwood, Erard, Steinway, Brinsmead, and other pianoforte makers, may be heard on the organs at the Albert Hall and Alexandra Palace, and at the Crystal Palace; also at St. Michael's Church, Cornhill. Exeter Hall organ is a little flatter, and about the pitch used in France just before the introduction of the Diapason Normal. To get the true sensation of these pitches, however, the organs should be heard at nearly 60° F., as they rise and fall rapidly with the temperature. But the interval between the highest and lowest of these pitches is only five-eighths of a tone, and merely represents the rise in pitch since the Congress of Vienna.

The great organ at Halberstadt (twenty-nine miles south-west of Magdeburg, in Prussian Saxony) was perhaps the first organ with three manuals and a pedal. It was finished February 23, 1361, by Nicholas Faber, and restored in 1495 by Gregory Kleng. It existed, unused, in the days of Prætorius, 1619, who figured its keyboards, described it, and gave the measurements of its largest pipe, B *natural*, four octaves below the B just above the bass staff, which was probably unaltered in length by Kleng, so that it gives a pitch 500 years old, the earliest I have been able to obtain. I had a pipe constructed to a scale of one-sixteenth, sounding four octaves higher, and by measuring its pitch at 59° F. under three inches' pressure of wind, I obtained A 506 (to the nearest whole number of vibrations to which I here limit myself). This is a minor Third above mean pitch, and five-quarters of a tone above our highest orchestral pitch. This estimate agrees with Prætorius's. Now this high pitch and a corresponding very low pitch are thus justified by Schlick of Heidelberg, 1511, who says: "The organ is to be suited to the choir and properly tuned for singing, for where this is not considered, persons are often forced to sing too high or too low, and the organist has to play the chromatics, which is, however, not convenient for every one. But what is the proper length of the pipes for this purpose, and convenient to the choir to sing to, cannot be exactly defined, because people sing higher or lower in one place than in another, according as they have small or great voices. However, if the longest pipe, the F below the Gamma ut [that is, F just below the bass staff], has its body down to the [beginning of the] foot, sixteen times the annexed line [which was $4\frac{3}{4}$ Rhenish inches long, so that the pipe was $6\frac{1}{3}$ Rhenish feet in length], I think it will be a suitable length for the choir. But if you build an organ a fifth larger, then you must make C in the pedal [that is, C on the second leger line below the bass staff] of this length." And then he goes on to explain how these dimensions best suit the ecclesiastical tones, going through each in succession, and gives the preference to the first pitch with the $6\frac{1}{3}$ Rhenish foot pipe on F. Now, making models of the proper dimensions, I found the first pitch was A 377, which is a whole tone flatter than mean pitch, and more than a minor Third flatter than our highest orchestral pitch; and the second pitch was A 504, that is, the same as the Halberstadt organ (for one or two vibrations are an insensible difference in organ pitch for the tuning A). We have then the same man, at the same time and for the same purpose—the

ease of playing and singing ecclesiastical tones—recommending two pitches a whole Fourth apart. The lower of these pitches was greatly developed in France. Delezenne found it as A 374 in a dilapidated organ near Lille, at L'Hospice Comtesse. I found it in a model of Dom Bédos's dimensions, 1766, and he is still the great authority on organ-building. Mr. Hopkins, of the Temple Church, found it probably in Strassburg on organs built for the French, about 1714, by the great German organ-builder, A. Silbermann. The Rev. Sir F. A. Gore-Ouseley says that most untouched organs in France are of this pitch. A great deal of this depth is to be attributed to the lengths of the foot to which builders worked. The old French foot was 6 per cent., the Rhenish foot 3 per cent. longer than the English; hence the pipes of a French, Rhenish, and English foot long differed so that the French was half and the Rhenish a quarter of a tone flatter than the English. Hence, when to raise the French pitch the French one-foot was made to sound B instead of C (as at Versailles, 1789, giving A 396), the pitch practically coincided with the English one-foot pipe put upon C (as at Trinity College, Cambridge, 1759). This seems to have been also the lowest Roman pitch very nearly (uncertain whether A 395 or A 404). Such was the low church pitch which was principally worked out in France, the English example being solitary so far as my researches extend.

The high church pitch was chiefly worked out in Germany, but seems also to have found favour in England before the Protectorate, and was also partially developed in France. In Germany we had Halberstadt and Schlick, already cited, and even at the present day we find A 484 at Lübeck Cathedral, A 481 at St. Catharine's, Hamburg, A 489 (formerly, now 494) at St. James's (St. Jacobikirche), in the same town. In England we had a pitch of A 474, recommended by Tomkins, 1668, and realised in Father Smith's old Durham organ, 1683, and his St. James's Chapel Royal Organ, 1708, and in Jordan's, St. George's, Botolph Lane, 1748, and probably in many other early English organs. Unfortunately the Puritans smashed all our English organs in 1644-46, so that with us organ tradition is rudely broken. Prætorius, however, mentions a pitch much used in churches in North Germany, which he persists, however, in calling chamber pitch. On examining the compass of the voice which he has written in this pitch, I find that it could not have been flatter than A 567, that is a Fourth sharper than mean pitch, so that it was related to mean pitch as Schlick's high to Schlick's low pitch. On comparing the highest notes which Orlando Gibbons (1583-1625) wrote for the different voices in his church music, with those assigned by Prætorius, 1619, it would seem that he used nearly this very high pitch, and Prætorius himself says that "the English pitch on instruments is a very little (*ein gar geringes*) lower." In France Mersenne's church pitch does not go higher than A 504, which agrees with Schlick and Halberstadt, that is it was a minor Third above mean pitch. And even in Prætorius's time organs were often at this pitch, or a tone flatter than his sharpest. In the Franciscan convent at Vienna we have the lowest form of this old high church pitch in its smaller organ, untouched since 1640, and giving A 458, practically our English highest concert pitch.

Early chamber pitch, like early church pitch, by which it was primarily determined, was also both high and low. As the same band played in church and chamber the differences were always some definite interval of the scale, so that they amounted to a transposition often very troublesome. The mean-tone scale may be considered to have been always in use at this period, as the numerous others which were invented were generally slight alterations of it. This scale differed from the modern equal scale in having a narrower whole tone and having two kinds of semitones, the large from B to C and E to F, the small from F to F *sharp*, B *flat* to B, that is for chromatic intervals. Expressed in vibrations, the great semitone was 7 per cent. of the vibrations of the lower note, the small semitone 4½ per cent., while the equal semitone is 6 per cent. and the just 6⅔ per cent. The mean tone is 12 per cent., the equal tone 12¼ per cent. All this rendered the mean-tone scale unsuited for transposition or for shifting of pipes in re-arranging an organ; yet both constantly occurred in former times. The higher chamber-pitch was generally a great semitone to a mean tone, or mean minor Third, or even a Fourth flatter than its corresponding higher church pitch. And these chamber pitches came to be used in churches in place of the highest church pitches. There seems little doubt that the high church pitches, except the very highest, were similar depressions of the very highest. In France, however, Mersenne, 1636, gives us a chamber pitch, A 563, which was a tone *higher* than his own high church pitch A 504, and corresponded to Prætorius's highest pitch already mentioned. These depressed church pitches were, however, still too high for most chamber music, and they were still further flattened. The most curious instances are in Hamburg, where the St. James's organ, 1688, built after the ecclesiastical tones of Roman Catholicism had become a tradition, was yet so high as A 489, and had on it one stop (as late as 1761, when it was removed), which was a whole minor Third *flatter* than the rest of the organ, that is, in the chamber pitch of the time and place. And Mattheson the composer (1681-1764), an early friend of Handel, had St. Michael's Church organ, to the building of which, in 1762, he contributed upwards of 3,000*l.*, tuned to A 408—most certainly the true chamber pitch of the time. It is curious that this pitch, a small semitone flatter than mean pitch, was as nearly as possible that used by Taskin, A 409, who was court-tuner to Louis XVI. in France, 1783, very nearly of the same time, and that this corresponds well with the pitch A 407 found by Sauveur in 1704. This became a low chamber pitch, and conflicted with that derived from the low-pitched organs.

Mean pitch, as I have termed it, seems to be the result of this conflict. This pitch was formally introduced by Prætorius as the most suitable pitch he could find for Protestant church music, and it was fixed by a drawing of the dimensions of his pipe, 1619, whence I had one constructed which gave C 507, corresponding to mean tone A 424, and this was also the precise pitch to which the London Philharmonic Society played from its foundation, 1813, to 1828. The mean pitch varied slightly within the limits A 415 (found in G. Silbermann's organ at the Roman Catholic Church, Dresden, 1722, as determined by forks chained to it by King Frederick August der Gerechte, which remained till 1824, one of which I have myself measured—this organ gave A 418 in 1878), and A 428, used by Renatus Harris, 1696. The mean of this is A 422½, which is the pitch of Handel's own fork, a pitch which I also found at Verona, and at Padua about 1780, and Delezenne found at Lille about 1754. This is also the pitch of Green's organs at St. Katharine's, London, and Kew Parish Church, both A 423, and St. George's Chapel, Windsor, A 428. The fork of Stein, maker of pianos to Mozart, was A 421½. Seville Cathedral and all Spanish church organs are about A 420 even now, which is also the pitch of G. Silbermann's Freiberg Cathedral organ. In recent times, 1860, this was the pitch of the Russian Court church band. The fork of the Opéra Comique in Paris, 1820, was A 423, and in 1823 was A 428. The fork of the Dresden Opera under Carl Maria von Weber (1813-21) was at A 423. In short throughout Europe this pitch prevailed, as shown by above sixty pitches which I have collected. The resonance of the air in the Cremona violins, about 1700, shows two maxima, the principal about C 270, and the other not so well marked, about C 252½, corresponding to A 451 and A 422. The latter is mean pitch; the former, a great semitone higher, was the corresponding chamber pitch. It was during this period that the founders of modern music wrote, and hence adapted their vocal music to mean pitch, which must be considered as the classical musical pitch, to which our present orchestral pitch stands in the relation of a chamber pitch a great semitone higher. The establishment of this fact is perhaps the most important practical conclusion of my investigations. A curious metrical relation also leads to a useful classification of old organs having the mean-tone temperament. Mean pitch corresponded to organs with a B-pipe one English foot long, and I call these B foot organs, A 419 to A 428. The old sharp English pitch of Father Smith at Durham had the one foot pipe on A, and I call these A foot organs, being a tone sharper than the other, A 468 to A 475. An intermediate medium pitch, also used by Father Smith at Hampton Court, into which his sharp pitch was frequently altered by shifting the pipes, had the one-foot pipe on B flat, A 438 to A 444. The lowest organs, of which that in Dr. R. Smith's time at Trinity College, Cambridge, is the only example I know for certain in England, had the one-foot pipe on C, and was a C foot organ, A 395 to A 404, which was equivalent to a French B foot organ, pitch A 396. The variation of pitch here indicated depends mainly on the difference of the "scale" or ratio of the diameter to the length of a pipe used by different builders. Of course the introduction of equal temperament has slightly altered these relations.

The unfortunate break-up of mean pitch in modern times seems to have been entirely accidental, and certainly bears no

trace of systematic plan or execution. It has been both aimless and vacillating—often merely capricious. I find no mention of any opposition to mean pitch till the French Conservatoire in 1812 used A 440, apparently as an experiment, for it found no adhesion. This pitch, afterwards proposed by Scheibler, and adopted by a congress of physicists at Strassburg in 1834, was really a resuscitation of the English B *flat* foot organ pitch. The great change was initiated by the presentation by the Emperor of Russia and an Austrian Archduke of sharper brass instruments to two household regiments in Vienna in 1816, and this subsequently entailed a rise at the two Vienna operas, which had to use these bands occasionally. The sharpening spread slowly and grudgingly through most of Germany. At Dresden it rose from the flutist Fürstenau getting a new flute from Vienna, but had not quite reached A 440 in 1862. At the celebrated Gewandhaus concerts at Leipzig the sharpening went on more rapidly to A 449 in 1859, and in France, after a very chequered career, the pitch of the Grand Opera, which was A 427 in 1811, and A 434 to 440 in 1829, where it remained to about 1854, became A 448 to 449 in 1858, when the great increase of pitch and the diversity of standards used in different towns induced the French Government to issue a commission, which resulted in establishing the French Diapason Normal A 435 in 1859. This pitch, being a quarter of a tone above mean pitch and about the same below the high orchestral pitch then reigning, enabled music of both kinds to be sung with tolerable ease. And this is of great importance, for we cannot afford to discard either classical or modern music, and to sing either to the pitch of the other is to do injustice to both composer and singer. The sudden change was, however, troublesome and expensive, although France, like England, had passed through that pitch without any complaint a few years before.

In England the increase of pitch abroad apparently induced Sir George Smart to alter the Philharmonic pitch about 1828, after consultation with singers, and he raised his fork to A 433, keeping, however, mean-tone temperament. This is practically the French normal, and the mean-tone C of Sir G. Smart actually coincides with the equally-tempered C of the French. This fork was long in use, and copies of "Smart's C" were greatly in vogue down to 1846 and later, stamped "Philharmonic," although the Philharmonic Society never issued a fork. But under the *bâton* of Sir Michael Costa the pitch rose rapidly, and the mean pitch from 1846 to 1854 was A 452½. The Society of Arts in 1859, in imitation of the French Commission, called together a large committee of musicians and men of science, who decided on C 528, to which they supposed would correspond A 440 (which would be just intonation), instead of A 444 (in equal temperament). Mr. Griesbach was commissioned to make the standard, but his C 528 turned out to be C 534·5, giving A 449·4, but incorrectly tuned as A 445·7 by a short monochord. Hence, in the market, the Society of Arts pitch is one of those very sharp pitches which it was intended to moderate. In 1874 the Philharmonic Concerts reached their maximum of A 454·7, and Steinway's pianos—which in England are at this pitch, in common with Broadwood's, Erard's, Brinsmead's &c.—at New York have gone up to A 457. Hence we have most undesignedly reached a chamber pitch, a great semitone above the classical music, and most unmusicianly play classical compositions written for mean pitch at this disfiguring sharpness. Covent Garden Opera has, however, resolved to adopt the French compromise system this season. Abroad in Germany, after a very general adoption of the French Normal, orchestral pitch again rose, and Vienna, which had reached A 456 before 1859, was at A 447 in 1878. The rest of Germany seems to be lower, Dresden intending to be A 440, but really slightly flatter. Bologna was A 443 in 1869, and the rest of Italy is probably not greatly different. There is, however, but one standard of pitch now in the world, the Diapason Normal at the Conservatoire at Paris, actually A 435·4, and even Belgium, which has a military standard of A 451 (the same as the British Army Regulation), had decided by a Commission to adopt French pitch, which only the expense of providing new instruments to the army at present prevents.

The above rapid survey of the history of musical pitch may be condensed into the following table, in which all such pitches as I have here mentioned, together with a few others, are included. The column T gives the number of *tenths* of an equal semitone by which any pitch exceeds the initial zero pitch, so that by subtraction of their *tenths* the interval between any two pitches in the table may be instantly ascertained. The column marked A gives the nearest whole number of vibrations of A in numerical order from the lowest to the highest, embracing an interval of a whole Fifth. As it takes an increase of two or three vibrations at these pitches to rise by the tenth of a semitone, the same tenths will be found to correspond to different numbers of vibrations, all being given to the nearest whole number only.

CONDENSED HISTORY OF MUSICAL PITCH

T.	A.	
		1. *Church Pitch Lowest.*
0	370	Zero pitch, not observed.
2	374	L'Hospice Comtesse, Lille.
3	377	Schlick, low, 1511; Bédos, 1766; French C foot organs; A. Silbermann at Strassburg, 1714.
		2. *Church Pitch Low.*
10	392	Euler's clavichords, St. Petersburg, 1739.
11	395	Trinity College organ, 1759; English C foot organs; Roman pitch pipes, 1720.
12	396	Versailles Chapel, 1789; French B foot organs.
		3. *Chamber Pitch Low.*
15	404	Roman pitch, 1730, from a fork.
16	407	Sauveur, Paris, 1713.
17	408	Mattheson, Hamburg, 1762.
"	409	Pascal Taskin, Paris, Court Clavecins, 1783.
		4. *Mean Pitch for Two Centuries, English B foot Organs.*
20	415	Chained fork of the Roman Catholic Church organ, built by G. Silbermann, 1722.
21	418	Same organ in 1878. Euler's organs, 1781.
22	420	G. Silbermann's Freiberg organ, 1714; Torje Bosch's Seville Cathedral organ, 1785; and all church organs in Spain.
23	422	Stein's fork for Mozart's pianos, 1780; Lower resonance of Cremona violins, 1700; Old fork at Lille, about 1754; Verona and Padua, 1780; Russian Court church band, 1860.
"	423	Handel's fork, 1751; Green's St. Katharine's, 1778, and Kew, 1790; Dresden Opera under Weber, 1815-21; Paris Comic Opera, 1820.
24	424	Prætorius's "suitable" church pitch, 1619; Original Philharmonic Concerts, 1813-1828.
25	427	Paris Grand Opera, 1811.
"	428	Renatus Harris's organs, 1696; Green's St. George's, Windsor Castle, 1788; Paris Comic Opera, 1823.
		5. *The Compromise Pitch.*
27	433	Sir George Smart's fork, 1828.
"	434	Paris Grand Opera, 1829.
28	435	French Diapason Normal, 1859.
		6. *Modern Orchestral and *Ancient Medium Pitch.*
30	440	Paris Conservatoire, 1812; Paris Opera, 1829; Scheibler's Stuttgart pitch, 1834; Dresden, 1862.
31	442	*Father Smith's (= Bernard Schmidt's) low pitch at Hampton Court Palace, 1690; English B flat foot organs.
"	443	Bologna, Liceo Musicale, 1869.
32	445	Madrid, Opera, 1858; Naples, S. Carlo, 1857.
"	446	Broadwood's medium, 1849-80; Paris, Grand Opera, 1856; Griesbach's A 445·7, 1860, for Society of Arts, meant for A 444.
33	447	Vienna Opera, 1878.
34	449	Paris Grand Opera, 1858; Leipzig, Gewandhaus Concerts, 1859; Griesbach's C 534·5, 1860, for Society of Arts, meant for C 528.
35	451	Lille Opera, 1848 and 1854; British and Belgian Military Instruments Standard, 1879; Higher resonance of Cremona violins about 1700.
"	453	Mean of the Philharmonic Concerts under Sir M. Costa, 1846-54.
36	455	Highest Philharmonic, 1874; Broadwood's, Erard's, Brinsmead's, and (English) Steinway's concert pianos, 1880.
"	456	Vienna celebrated high pitch before 1859.
37	457	(American) Steinway's pianos.
		7. *Church Pitch High.*
37	458	Vienna, large Franciscan organ, 1640.

T.	A.	
43 ...	474 ...	Tomkins's standard, 1668; Father Smith's high pitch at old Durham and old St. James's Chapel Royal organs, 1683 and 1708; the Jordans, at St. George's, Botolph Lane, 1748; English A foot organs.
45 ...	481 ...	St. Catherine's, Hamburg, 1543.
46 ...	484 ...	Old smaller organ in Cathedral, Lübeck.
48 ...	489 ...	St. James's (S. Jacobi), Hamburg, original pitch, 1688.
		8. *Church Pitch Highest.*
50 ...	494 ...	St. James's (S. Jacobi), Hamburg, present pitch, 1879.
51 ...	496 ...	Rendsburg organ, 1668.
53 ...	504 ...	Schlick's high pitch, 1511; Mersenne's *ton de chapelle*, 1636.
54 ...	506 ...	Halberstadt organ, 1361.
		9. *Church Pitch Extreme and Chamber Pitch Highest.*
73 ...	563 ...	Mersenne, *ton de chambre*, 1636.
74 ...	567 ...	Usual church pitch in North Germany in 1619, called chamber pitch by Prætorius. Probable pitch of church music of Orlando Gibbons (1583-1625).

ALEXANDER J. ELLIS

THE ATOMIC WEIGHT OF ANTIMONY[1]

IN a previous paper on this subject,[2] we gave our reasons for the opinion, since fully confirmed, that the bromide of antimony is the most suitable compound of this element, as yet known, for determining its atomic weight; and the results of fifteen analyses of five different preparations of the bromide were published, which gave for the atomic weight in question the mean value 120·00 with an extreme variation between 119·4 and 120·4 for all the fifteen analyses, and between 119·6 and 120·3 for the six determinations in which we placed most confidence. The antimonious bromide used in these determinations was purified first by fractional distillation, and secondly by crystallization from a solution in sulphide of carbon. In the crystallised product thus obtained, the bromine was determined gravimetrically as bromide of silver in the usual way. Although it seemed at the time that the results were as accordant as the analytical process would yield under the unfavourable conditions, which the presence of a large amount of tartaric acid in the solution of the bromide of antimony necessarily involved; yet it was obvious that the agreement was far from that which was desirable in the determination of an atomic weight, and our chief confidence in the accuracy of the mean value—independently of its remarkable agreement with previous results—was based on the fact that the known sources of error tended to balance each other. Hence our conclusions were stated with great caution, and the hope was expressed that after a more thorough investigation of the subject we might be able "to return to the problem with such definite knowledge of the relations involved as will enable us to obtain at once more sharp and decisive results than are now possible." Unfortunately this investigation has been delayed by causes beyond our control.

In our previous paper we described a simple apparatus which we devised for subliming iodide of antimony; and in a note to the paper we stated that we were applying the same process to the preparation of the bromide of antimony, and that it promised excellent results. Our expectations in this respect have been fully realised, and the product leaves nothing to be desired either as regards the beauty or the constancy of the preparation. The fine acicular crystals are perfectly colourless, and have a most brilliant silky lustre. With ordinary precautions they can be kept indefinitely without change, and it is easy therefore to determine the weight of the material analysed to the tenth of a milligramme.

We have carefully studied the causes of error involved in the analytical process of determining bromine in an aqueous solution of bromide of antimony and tartaric acid by the usual gravimetric method. These causes we propose to discuss in a future more extended paper. In this preliminary notice we have only space to state that we have satisfied ourselves that the small differences between the results previously obtained arose wholly from the analytical process, and not from any want of constancy in the material analysed; and further that these sources of error are to a very great extent under control. Moreover, we have found that the volumetric determination of bromine by silver was not materially affected, if at all, by the same causes. We have thus been led to devise a mode of testing the atomic weight of antimony, which, while it has all the advantages of the gravimetric method previously employed, is free from its sources of error.

If the atomic weight of antimony were 122·00, it would require 1·7900 grammes of pure silver to precipitate the bromine from a solution of 2·0000 grammes of antimony bromide, while if the atomic weight of antimony were 120·00 it would require 1·8000 grammes of silver. Now it is easy to estimate volumetrically $\frac{1}{100}$ of this difference with great certainty. We therefore prepared with great care a button of *pure* metallic silver, which we annealed and rolled out to a thin ribbon. We then weighed out from two to four grammes of bromide of antimony, prepared by sublimation as described above, and dissolved this salt in an aqueous solution of tartaric acid, which we then transferred to a litre flask and diluted to about 500 cubic centimetres. We next very accurately weighed out a quantity of silver slightly less than that which calculation showed was required for complete precipitation. This silver was dissolved in nitric acid, and the solution having been evaporated to dryness over a water bath, the silver salt was washed into the flask containing the bromide of antimony. As soon as the supernatant liquid had cleared, the small additional amount of a normal silver solution required to produce complete precipitation was run in from a burette, and measured with the usual precautions. We used no extraneous indicator, because it was important not to introduce any possibly new disturbing element into the experiment, and in the titration of bromine with silver the normal and familiar phenomena, which mark the close of the process, furnish a very sharp indication. The details of one of the determinations were as follows:—

The weight of the bromide of anatomy used amounted to 2·5032 grammes. To precipitate the bromine from the solution of this material 2·2404 grammes of silver would be required if Sb = 122·00 and 2·2529 if Sb = 120·00. We weighed out, with as much accuracy as if we were adjusting a weight, the smaller of these two quantities of metallic silver, and after dissolving the pure metal in pure nitric acid, evaporating the solution to dryness and redissolving in water, we added at once the whole of this silver solution to the litre flask containing the solution of bromide of antimony, in the manner described above. It was then found that $12\frac{4}{10}$ cubic centimetres of a normal silver solution (one gramme of silver to the litre) were required to complete the precipitation. It will be seen that the weights of the bromide of antimony and silver used could be thus determined with the most absolute precision, and we have the greatest confidence in these values to the $\frac{1}{10}$ of a milligramme. Moreover, it will be noticed that the volumetric method is only used to estimate the difference in the atomic weight which has been in question, and that if the method were only accurate to the $\frac{1}{10}$ of the quantity to be measured it would give us the value of the atomic weight within $\frac{2}{10}$ of a unit; while if, as we had reason to believe, the process was accurate within 1 per cent, it would fix the atomic weight within $\frac{2}{100}$ of a unit.

By the method just described, the following results were obtained. The letters *a* and *b* indicate different preparations.

	Wt. of Sb Br_3 taken.	Total wt. of Ag used.	Per cent. of Br Ag=108 Br=80.	Corresponding value of Sb.
a 1.	2·5032	2·2528	66·6643	120·01
a 2.	2·0567	1·8509	66·6620	120·02
a 3.	2·6512	2·3860	66·6644	120·01
b 4.	3·3053	2·9749	66·6696	119·98
b 5.	2·7495	2·4745	66·6653	120·01
		Mean value	66·6651	120·01

Mean value of fifteen gravimetric determinations previously published	66·6665
Theory Sb. 120 requires	66·6666
" Sb. 122 "	66·2983

In order still further to control the work, we collected the bromide of silver formed in the last two determinations, washing the precipitate with the precautions which experience had shown to be necessary, and determining its weight, first, after drying at 150° C, and, secondly, after heating to incipient fusion. In

[1] Contributions from the Chemical Laboratory of Harvard College. Preliminary notice of Additional Experiments. By Josiah P. Cooke, Erving Professor of Chemistry and Mineralogy.

[2] *Proc.* Amer. Acad. Arts and Sciences, vol. xii. page 1.

b 6 there was a loss of $\frac{1}{10}$ of a milligramme; in *b* 7 a loss of $\frac{2}{10}$ of a milligramme only at the second weighing. This is an absolute proof that there could be no sensible occlusion of any tartaric acid or any tartrate by these precipitates, and, as stated in our original paper, the same test was frequently applied, although not always in our previous determinations. It is also evident that these last experiments give us two essentially distinct determinations of the atomic weight, although the materials employed were identical with those of *b* 4 and *b* 5.

Wt. of Sb Br_3 taken.	Wt. of AgBr determined.	Per cent. of bromine Ag=108 Br=80.	Corresponding value of Sb.
b 6. 3·3053	5·1782	66·665	120·01
b 7. 2·7495	4·3076	66 667	120·00
Mean value	... ...	66·666	120·00

Lastly, it is obvious that these gravimetric determinations, taken in connection with the corresponding volumetric results, give us the most conclusive evidence of the purity, both of the metallic silver used, and also of the bromine in the bromide of antimony, which is the basis of this atomic weight investigation. By comparing *b* 6 and *b* 7 with *b* 4 and *b* 5 respectively, we obtain the following data:—

1. 2·9749 gram. of silver gave 5·1782 gram. bromide of silver.
2. 2·4745 „ „ 4·3076 „ „

Hence it follows that, as shown by these experiments, the proportions of the silver to the bromine were respectively:—

1. 108·00 Silver to 79·99 Bromine.
2. 108·00 „ 80·01 „

Mean value 108·00 „ 80·00 „

This is the ratio of the atomic weight of silver to that of bromine, and corresponds to the second decimal place with the determinations of Stas as well as with those of Dumas.

In conclusion it gives us pleasure to express our obligations to Mr. G. De N. Hough and Mr. G. M. Hyams, two students of this laboratory, who have greatly aided us in the experimental work of this investigation.

SOCIETIES AND ACADEMIES

London

Royal Society, March 11.—"Report on the Fossil Flora of Alum Bay," by Baron Ettingshausen. The materials upon which the report is based were stated to be in the British Museum, Museum of Practical Geology, Woodwardian Museum, and in Mr. J. S. Gardner's collections. The fossil flora of Alum Bay contains, according to the author, about 116 genera and 274 species belonging to 63 families. Of these genera 3 are said to be Thallophyta, 2 Filices, 5 Gymnospermæ, 6 Monocotyledons, 28 Apetalæ, 15 Gamopetalæ, 54 Dialypetalæ, and 2 indeterminable. A number of genera are enumerated which the author supposes to be common to Alum Bay and Sheppey, and hence he infers, as Heer did, that there is a close connection between the two floras. The small number of ferns and palms in comparison with the much greater number at Bournemouth and of palms at Sheppy is remarkable. Many of the dicotyledons are stated to show a genetic connection with miocene species, and a great number of the latter are seen to have originated as far back as the eocene. On the other hand some of the miocene genera were not completely differentiated into genera in the eocene period. Two examples are given: Castanea, which although perfectly developed in the miocene, is said to be only represented in the eocene by a castanea-like oak, uniting characters now distinctive of the two genera, and a Pomaderris-like Rhamnus, also seeming to unite two genera which were quite distinct from each other in the miocene.

More than fifty of the species from Alum Bay are common to Sotzka and Hæring, while a lesser number are common to Sézanne, the Lignitic of America, and to other floras. The paper includes a list of species.

In the discussion Dr. Carruthers could not quite agree with determinations which brought together plants from all parts of the globe. Mr. Mitchell questioned the utility of giving specific names to plant remains that are neither described nor figured, especially when no nearer approximation to their position can be made than is indicated by the terms Carpolithes and Phyllites. Mr. Gardner explained the position of the leaf-bed at Alum Bay, stating it to be a small vertical clay basin, similar to those found in a horizontal position near Bournemouth; and hence he did not consider it remarkable that the flora from Alum Bay should appear restricted (as indicated by the paucity of palms and ferns) by comparison with the Bournemouth flora, which has been obtained from a series of basins extending for several miles.

Chemical Society, March 30.—Anniversary meeting.—Mr. Warren De la Rue, president, in the chair. The president, in his annual address, contrasted the condition of the Society during the past year with its position in 1869. The number of Fellows has increased from 522 to 1,034, the income from 1,100*l.* to 2,700*l.*; papers read from 31 to 75. A rapid glance was then taken of the recent progress of chemistry, especial reference being made to the decomposition of the elements chlorine, bromine, &c., by Meyer; the photographs of the whole of the spectrum recently made by Capt. Abney; the artificial production of the diamond by Hannay; the synthesis of vegetable colouring matters and alkaloids; the discovery of a new element, scandium, &c. The officers for the ensuing year were then balloted for; the following were elected:—President—H. E. Roscoe. Vice-presidents—F. A. Abel, C.B., B. C. Brodie, Warren De la Rue, E. Frankland, J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, A. W. Williamson, J. Dewar, J. H. Gilbert, N. S. Maskelyne, V. Harcourt, R. Angus Smith, J. Young. Secretaries—W. H. Perkin, H. E. Armstrong. Foreign Secretary—Hugo Müller. Treasurer—W. J. Russell. Other members of council—M. Carteighe, C. Graham, C. W. Heaton, H. McLeod, E. J. Mills, J. M. Thomson, W. C. Roberts, W. A. Tilden, W. Thorp, T. E. Thorpe, J. L. Thudichum, R. Warington.

Anthropological Institute, March 23.—Edward B. Tylor, F.R.S., president, in the chair.—A paper by Mr. V. Ball, M.A., F.G.S., on Nicobarese ideographs was read. As the Andamanese may be said to have not progressed in civilisation beyond that stage which was represented by the people of the early stone periods in Europe, so the Nicobarese, who are much less savage and degraded than their neighbours of the Andamans, may justly be compared with the inhabitants of the "bronze period." The example of Nicobarese picture-writing described by the author was obtained in the year 1873 on the island of Kondul, where it was hanging in the house of a man who was said to have died a short time previously; it is now in the Museum of Science and Art at Dublin. The material of which it is made is either the glume of a bamboo or the spathe of a palm which has been flattened out and framed with split bamboos. It is about three feet long by eighteen inches broad. The objects are painted with vermilion, their outlines being surrounded with punctures which allow the light to pass through. Suspended from the frame are some cocoanuts and fragments of hog's flesh. The figures of the sun, moon, and stars occupy prominent positions. Attention was directed to M. Maclay's description of a Papuan ideograph which symbolised the various guests present at a feast given in celebration of the launch of two large canoes (*vide* NATURE, vol. xxi. p. 227).—Mr. Alfred Tylor read a paper on a new method of expressing the law of specific changes and typical differences of species and genera in the organic world, and especially the cause of the particular form of man. The lower animals have no abstract ideas, and therefore all they can know must be derived from objects. Their reproduction of specific form and decoration seems to prove that they possess a mental power of appreciating the niceties of form and colour in a very high degree. The forms and decorations of organised beings seem to be regulated by laws which the author provisionally called *emphasis* and *symmetry*. Emphasis was defined as the marking out by form or decoration of the important parts or organs. The law of emphasis, as applied to human work, was illustrated by the structure of a Greek temple, in which all the parts have their functions expressed or emphasised by ornament. It is a remarkable fact, and one that can scarcely be accidental, that just as animals fall naturally into two great classes, the *vertebrata* and *invertebrata*, so the emphasised functional decorations group themselves into two classes, and these two classes are identical with the vertebrata and the invertebrata. In the vertebrata the emphasised ornamentation is what we may call axial, being the outward expression of the central axis or vertebral column with its appendages; and in the invertebrata the decoration tends to follow the outline of the animal, and so develops borders. It has always excited wonder that the child—a separate individual—should inherit and

reproduce the characters of its parents and indeed of its ancestors, but if we remember that the great law of all living matter is that the child is *not* a separate individual, but a part of the living body of the parent, up to a certain date, when it assumes a separate existence, then we can comprehend how living beings inherit ancestral characters, for they are parts of one continuous series in which not a single break has existed or can ever take place. Just as the wave-form over a pebble in a stream remains constant, though the particles of water which compose it are ever changing, so the wave-form of life, which is heredity, remains constant, though the bodies which exhibit it are continually changing. Mr. Tylor's paper was illustrated by a large number of diagrams.

Royal Microscopical Society, March 10.—Dr. Beale, F.R.S., president, in the chair. Fifteen gentlemen were nominated or elected Fellows.—Mr. Beck exhibited an improved form of microscope with swinging sub-stage; Mr. Mayall a new traverse lens, by Mr. Tolles; Mr. Dunning a new form of turn-table; Dr. H. Gibbes a $\frac{1}{12}$-homogeneous immersion objective for use with the binocular; and Mr. Crisp Klönne and Müller's demonstration microscope and a specimen of micrometric ruling by Prof. Rogers, of Harvard, U.S.—Mr. James Smith described his method of illumination for high powers.—The following papers were read:—On a sponge parasitic within *Carpenteria raphidodendron*, by Prof. Martin Duncan, F.R.S.—On a petrographical microscope, by M. Nachets.—On double and treble staining of animal tissues, by Dr. H. Gibbes.—On *Podophyra quadripartita*, by Mr. Badcock.

Institution of Civil Engineers, March 23.—Mr. W. H. Barlow, F.R.S., president, in the chair.—The paper read was on explosive agents applied to industrial purposes, by Prof. Abel, C.B., F.R.S.

EDINBURGH

Royal Society, March 15.—Lord Moncrieff, president, in the chair.—By request of the Council, Lieut. Conder, of the Royal Engineers, gave an interesting and detailed lecture on the topography of Jerusalem.—Dr. James Geikie presented a communication on the geology of the Farö Islands, which he had visited last summer in company with Mr. Amund Hellend, of Christiania. In the absence of the author, the paper was read by Prof. Geikie. It was divided into two portions, the first treating of the more purely geological characteristics of the islands, which consist mainly of miocene volcanic formations intermingled with coal and clay deposits and attaining a thickness of from 10,000 to 12,000 feet; and the second part bearing particularly upon the evidences of glacier action. There were all the indications of prolonged glaciation, striæ, moraines, boulder-clay, &c.; but there was no evidence that this action was the result of a great ice-drift from the north. Everything indeed proved the glaciation to have been purely local.—Prof. Tait communicated a note on the colouring of maps. This he reduced to the problem of so lettering by the fewest possible symbols a number of points in a plane which have been joined two and two by non-intersecting lines so as to form three-sided areas, that no two connected points shall have the same name.

PARIS

Academy of Sciences, March 29.—M. Ed. Becquerel in the chair.—The following papers were read:—Application of the theory of sines of superior orders to the integration of differential linear equations, by M. Villarceau.—On the determination of high temperatures, by MM. Sainte-Claire Deville and Troost. They describe an improved form of apparatus they used in 1863 (primarily for determining the expansion of porcelain) now simplified by use of a Sprengel *trompe*, by means of which may be removed and measured, whenever desirable, the thermometric matter (nitrogen) contained in the porcelain reservoir, and the temperature be calculated.—On the hypergeometric series of two variables, and on simultaneous differential linear equations with partial derivatives, by M. Appell.—On a class of functions of several variables drawn from inversion of integrals of solutions of differential linear equations, the coefficients of which are rational functions, by M. Fuchs.—On the manner in which frictions come into action in a fluid which departs from the state of rest, and on their effect in preventing the existence of a function of velocities, by M. Boussinesq.—Memoir on integrations relative to the equilibrium of elasticity, by M. Mathieu.—Researches on diffusion, by M. Joulin. This first portion relates to condensation of various gases by porous bodies (charcoal, dry or saturated with liquid), the pressure being varied from a few centimetres to 4 atm., and the temperature from 0° to 100°. The absorbent was put in a glass tube which communicated (through tubes with cocks) with a manometric reservoir and a mercury pump. *Inter alia*, the saturation of dry charcoal with oxygen, nitrogen, or hydrogen is instantaneous, but with carbonic acid slow. Saturation with gaseous mixtures is slower than that with each of the constituent gases. Charcoal soaked with alcohol condenses much less than if soaked with water, and is saturated with gas much more slowly.—On a new property of vanadates, by M. Hautefeuille. Vanadates fused in contact with air rapidly take up a constant quantity of oxygen (bi-vanadate of lithia absorbs in a few minutes more than eight times its volume of this gas at a dark red, and liberates this gas at about 600° during crystallisation). Vanadates liberate *in vacuo*, in passing from the vitreous to the crystalline state, quantities of oxygen variable with the proportions of acid and base, and the nature of the base. This has a bearing on determination of equivalents.—On some properties of mixtures of cyanide of methyl with ordinary alcohol and with methylic alcohol, by MM. Vincent and Delachanal. The topics treated are the boiling points and densities of the mixtures, and a rational method of separating cyanide of methyl from ordinary alcohol.—Experiments showing that the anæsthesia due to certain lesions of the cerebro-rachidian centre may be replaced by hyperæsthesia under the influence of another lesion of that centre, by M. Brown-Sequard. Among other conclusions, the theory that the conductors of sensitive impressions of the limbs intercross in the spinal cord must be rejected; and one lateral half of the base of the brain may suffice for the transmission of sensitive impressions from both sides of the body.—Reflex effects of ligature of one pneumogastric on the heart after section of the opposite pneumogastric, by M. François-Franck. In this a retardation or arrest of the heart occurs, almost as notable as if the cut nerve had been intact; this effect is shown to be reflex. He studied the phenomenon in relation to time, with what he calls a *nevrotome à signal electrique*.—Contribution to the study of the transmission of tuberculosis, by M. Toussaint. From experiments on pigs he infers that where tuberculosis occurs in those animals it is analogous to galloping consumption in man. The bovine species, on the other hand, which have tuberculosis much more often, have most often the chronic variety. Hence young pigs from tubercular parents soon die, and in adults which become tubercular the quick progress of the affection prevents reproduction. The facts also prove that tuberculosis is transmitted with the greatest facility (1) by ingestion of tubercular matters, (2) by heredity or lactation, (3) by inoculation with tubercular matter or blood, (4) by simple cohabitation.—On a mode of treatment of certain infantile cases of deafness or deaf-mutism, by M. Boucheron. The cases referred to are those arising from naso-pharyngeal catarrh, causing the mucus of the Eustachian tube to swell and stop the passage, the stirrup bone, ere long, being, through pressure of external air on the tympanum, made to press strongly on the liquid of the labyrinth, injuring the acoustic nerve. M. Boucheron chloroformises the child and practises catheterism, insufflation of air, and pharyngeal cauterisation with a brush dipped in iodine solution.

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